FISHERIES BULLETIN No. 2

COLONY OF SINGAPORE

FISHERIES SURVEY REPORT

No. 1

AN INTRODUCTION TO THE FISHERIES SURVEY OF THE COLONY OF SINGAPORE, WITH A CONSIDERATION OF THE METHODOLOGY EMPLOYED

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GENERAL INTRODUCTION TO FISHERIES SURVEY REPORTS

THE Colony of Singapore, excluding the distant Christmas and Cocos-Keeling Islands, supports a civil population of more than one million persons although it covers an area of 220 square miles only. It is, therefore, not surprising that the major food supplies must be imported and this dependence upon external supplies has been accentuated by the commercial development on which the prosperity of the Colony is founded. Moreover, the position is aggravated by the restriction, rarely enforced in the pre-war period, on fishing by non-residents in the adjacent interlacing waters of the Riouw Archipelago, the virtual closure of the open seas to the east by adverse weather conditions during the north-east monsoon and the limited resources available in the Malacca Straits in the west and north, which are already heavily fished by the fishermen of Indonesia and the Federation of Malaya.

Local fishermen produced only 30.4 per cent of the total quantity of fresh fish which passed through the auction markets of this Colony in 1950. It is true that local production also supplies residents in the areas adjacent to minor landing points, a supply which until recently was not included in the estimate of the total supply available to the Colony's population. Despite this, the fact remains that local supply falls far short of the total requirements even in times when reduced prosperity has restricted the demand for higher quality fish. This deficiency is important from the viewpoint of self-sufficiency of the Colony in relation to its general economic structure. But in addition, the imported supply is of such a large proportion that its characteristics, such as composition, fluctuations in level, cost and so forth, exercise a considerable influence on the fish markets of the Colony.

For a number of years there have been complaints from all sections of the community concerning the fish supplies. High prices, uncertain quality and irregularity in supplies have been the major charges, although frequent references to unfair practices which give the fishermen small returns whilst overcharging the consumer have been publicised freely. Explanations and refutations of the charges have been offered from time to time by groups concerned and it was difficult, with the information available, to recognise the principal issues at stake. Certain matters, such as the proportion of imports in the total supply, the unsatisfactory facilities available in the marketing industry, the complexity of the distribution system, are patent to any observer. Other information such as some of the biological aspects of the local supply and the relative significance of various elements of the production and distribution system were known to the fisheries officials concerned. However, the more intricate features of the system, the real factors affecting supply both local and imported, the factors determining costs of production and so forth were, at best, known only in a qualitative sense.

Under the circumstances it was natural that a decision should be reached that work should be undertaken to make a detailed, intensive study of the industry. Before any remedies might be considered it was obviously necessary to obtain a proper understanding of the defects which were to be cured, and this in itself would imply an understanding of the causes of these defects. Furthermore, whatever course of action might be decided upon, it was obvious that Government should be informed of the day to day operation of the industry.

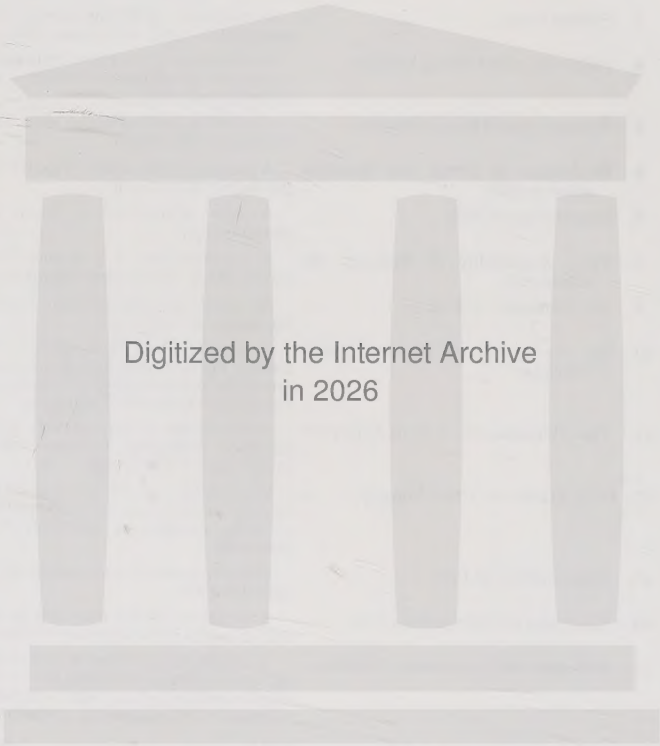
July 77
Heath

Accordingly a survey of the industry was initiated. The scope of the survey may be judged from the following list of reports in course of preparation:—

No.	*Short Title*	*Schedule of Contents*
1.	Introduction to the Fisheries Survey ..	Brief statement of the history of the marketing committee—detailed account of the framework of the survey and statistical methods employed.
2.	Fishing Gear	A classification—description of each gear, its use and distribution, cost, productivity, methods of preservation and materials used.
3.	Fishing Boats	A catalogue of fishing boats, their use and distribution, costs and preservation.
4.	Fishermen and Fishing Villages ..	A statement of the permanent and temporary manpower available to industry, services and facilities available.
5.	Production of Marine Fisheries ..	A study of production by local fishermen and the factors affecting it.
6.	Production in Fresh and Brackish water ponds	A study of production by local fishermen and the factors affecting it.
7.	Importation of Fish	A study of the level of import and factors determining it.
8.	Total Availability of Fish to the Consumer	A consolidation of 5, 6 and 7 with critical examination and recommendations.
9.	The Transport of Fish	An enumeration of transport employed, loading statistics, costs, etc.
10.	The Production of Ice and Allied Industries	A description of the availability of ice, cold storage facilities and storage arrangements with particular reference to the efficiency and financial features of these allied industries.
11.	The Marketing of Fish in Singapore	A description of the markets and marketing facilities including a consideration of the machinery of marketing.
12.	Fish Prices and Price Margins ..	Examination of fish prices at each stage and factors determining prices, a critical examination of price margins as compared with services provided.
13.	Consumption of Fish	Consideration of the consumption of fresh and salt, dried fish.
14.	Catalogue of Marine Resources ..	A catalogue of the resources of the area that are or might be of commercial importance.
15.	A Report on Development Projects ..	A consideration of the results of developmental work undertaken during the survey or on the implementation of any interim recommendations accepted by the marketing committee.

It will be seen that a full account will be given of all sections of the industry and that it is expected to synthesise from these a single account of the operation of the industry on the basis of which proposals will be made for further Governmental action in respect of the industry.

The present report gives an account of the statistical programme which has been developed for the purposes of this survey. It is clear that many of the elements of the industry are best regarded from the statistical viewpoint and much of the survey work has inevitably been and will continue to be concerned with the collection of statistical data. The series of such data are listed and described here and an account is given of the methods which are being employed in this work: the report also shows the general nature of the results which are emerging from this work and the directions in which these results point in respect of further work.



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CONTENTS

	Page
1. INTRODUCTION	
1.1 General	1
1.2 Brief Description of the Industry	3
1.3 The use of Statistical Methods in the Survey	5
2. THE COLLECTION OF DATA	
2.1 Framework of Record	21
2.2 Collection Programme	27
3. DESCRIPTION OF THE DATA AVAILABLE (COMPILATION PHASE) ..	30
4. TREATMENT OF THE DATA (ANALYSIS PHASE)	
4.1 General Principles of Treatment	35
4.2 Examination of Total Market Supplies and of the factors influencing the movement of supplies into the various channels of distribution	36
4.3 Estimation of Production and Determination of the Factors affecting production	68
4.4 Estimation of Price and Assessment of factors affecting price levels at various stages	79
5. DISCUSSION	
5.1 Preliminary Interpretation of the Results to the Present Stage	92
5.2 Indications as to Future Programme	95
6. CONCLUSION	96
7. GLOSSARY	97
8. APPENDICES	
I. Forms used in Licensing Fishing Craft and Gear	
A Fishing Boat Licence	100
B Fishing Gear Licence	101
II. Use of Sampling Methods in the Fisheries Survey ..	102
III. Source References for recent Statistical Series	112
9. STATISTICAL BIBLIOGRAPHY	119

ILLUSTRATIONS

Figures *Page*

1. Fishing Villages and Markets 2
2. Movements of Fresh Fish Supplies to Singapore 4
3. Cultural Operations 6
4. Diagram showing Factors determining Production .. 20
5. Channels of Movements of Fish Supplies 22
6. Structure of Fishing Industry 24

---

*Graphs**

1. Yearly Total Wet Fish Auctioned in the Wholesale Markets (1924–1938 and 1947–1950) 38
2. Monthly Total Wet Fish Auctioned in the Wholesale Markets .. 40
3. Monthly Average Daily Market Handlings (All Areas of Origin) 42
4. Monthly Average Daily Market Handlings of Riouw and Local Origin 43
5. Monthly Average Daily Market Handlings of East Johore Origin 44
6. Monthly Average Daily Market Handlings of West Coast of Malaya and South Johore Origin 45
7. Monthly Average Daily Market Handlings of Sumatran Origin 46
8. Monthly Average Daily Market Handlings of East Coast of Malaya 47
9. Mensal Lunar Average Daily Handlings (in thousand katties) with Associated Phenomena
   - *A*. Actual Landings 49
   - *B*. Adjusted Landings 49
   - *C*. Moon Phase 49
   - *D*. Average Diurnal Tidal Variation 50
   - *E*. Average Daily Residual Landings 50
10. Lunar Mensal Average Daily Market Handlings
    - *A*. 1st to 6th Chinese Lunar Months 52
    - *B*. 7th to 12th Chinese Lunar Months 53

*Graphs**			Page
11.	Lunar Monthly Average Daily Handlings Showing Seasonal Variation		54
12.	Average Lunar Monthly Total Handlings		55
13.	*Pari* Handlings in Municipal Markets		60
	(*A*) Lunar Mensal Average for the lunar year ending 5–2–51		
	(*B*) Lunar Monthly Totals for the lunar year ending 5–2–51		
14.	*Chencharu*	do.	61
15.	*Terubok*	do.	62
16.	*Kembong*	do.	63
17.	*Merah*	do.	64
18.	*Tenggiri*	do.	65
19.	*Parang*	do.	66
20.	*Kurau*	do.	67
21.	Estimated Monthly Production and Monthly Total Market Handlings of Local Origin (1950)		77
22.	Lunar Mensal Average Daily Market Handlings of Local Origin		78
23.	Correlation of Fish Prices with various Economic Factors for 3 Calendar Years (1948–1950)—		
	A. Monthly Average Daily Retail Price for Various Categories of Fish for the Period January 1948–December 1950 (cents per katty)		84
	B. Monthly Average Daily Price of Rubber (cents per lb.) ..		85
	C. Monthly Volume of Trade with Indonesia (Millions of Straits $). Singapore Wet Fish Landings (Hundred Tons) ..		86
24.	Lunar Mensal Average Daily Retail Price for the lunar year ending 5–2–51. *Kurau*, *Tenggiri* and *Parang*		87
25.	do.	*Chencharu* and *Pari*	88
26.	do.	*Merah*, *Terubok* and *Kembong* ..	89
27.	Relationship between Supply and Demand for Certain Types of Fish during the Lunar Year ending 5–2–51		90–91
28.	Frequency Distribution of Catch of *Kelongs*, Stratified by Average Catch		106

*Graphs relate to the years 1947–1950 in respect of calendar months and to the period 2–1–47 to 5–2–51 for lunar months of 4 lunar years unless otherwise stated.

Tables		*Page*
I	Wet Fish Handlings in Municipal and Private Auction Markets for the Years 1947 to 1950 (in long Tons)	10–11
II	Inventory of Fishermen, 1947 to 1950	12
III	Inventory of Licensed Fishing Boats, 1947 to 1950 ..	12–13
IV	Inventory of Fishing Gears, 1948 to 1950	14
V	Inventory of Cultural Operations	15–16
VI	Inventory of Fishermen, Boats and Gear by Area, 1950 ..	17–19
VII	Yearly Total Wet Fish Auctioned in Singapore Municipal and Private Markets by Localities (1924–1938 and 1947–1950). (Quantities shown as Index on Local Handlings in 1924) ..	39
VIII	Monthly Erratic Variation in Wet Fish Handlings (22–1–47 to 5–2–51)	56
IX	Composition of Municipal Market Handlings by Type (1938 and 1950)	58
X	Summary of Fishing Units under Survey (1950–1951) ..	71–72
XI	Estimated Local Production (*Pukat tarek*) (January 1951) ..	74
XII	Estimated Total Production of Wet Fish in Local Waters ..	75
XIII	Monthly Average Daily Retail Prices (1947 to 1950) ..	82–83
XIV	Magnitude of Seasonal and Lunar Effects (1947–1950) ..	93

Appendix II

A.	Estimated Local Catch by Major Fishing Gears	103
B.	Monthly Mean Daily Catch of Various Units (*Kelongs*) ..	104–5
C.	Frequency Distribution of Daily Catches of *Kelongs* ..	107
D.	Analysis of Variance for Main Effects of Daily Catch by 22 *Kelongs*	108
E.	Analysis (Incomplete) of Variance of Daily Catch by 3 *Kelongs* at One Locality in One Depth	108
F.	Parameters of Daily Catch of Various *Kelongs* grouped into Strata	109
G.	Mean Daily Catch Taken by 6 *Pukat Tarek* Units	110
H.	Analysis of Variance of Catch by 6 *Pukat Tarek* Units ..	110
I.	Analysis of Variance of Monthly Mean Daily Catch of Fifteen *Jaring Hanyut* Units	111

I. INTRODUCTION

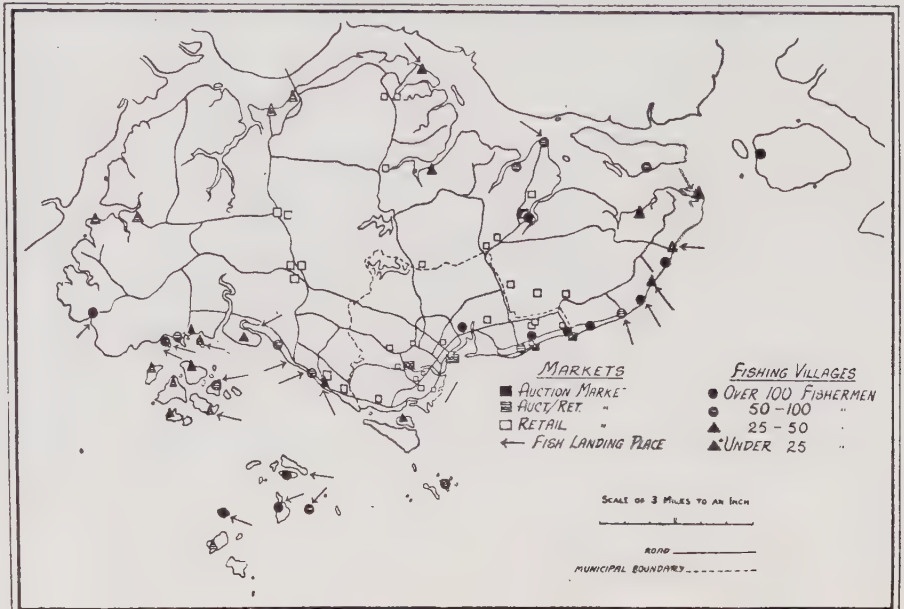
1.1 GENERAL

In the general introduction to this series, of which this is the first report, a brief account is given of the background to this survey. Very briefly re-stated, the problems are inadequacy of supplies, high prices and inefficient means of distribution. The objectives are to solve, or at least to alleviate these problems, and it is apparent that there are numerous possible courses of action. Various measures may be taken to bring about an increase in production: new types of gear may be tested and, if proved successful, brought into use; vessels may be mechanised; new grounds may be sought; various conservational measures may, on the basis of biological findings, be applied to existing operations to bring about improvement in the quantity and quality of their catch; various forms of assistance may be given to the fishermen. Again various steps may be taken to facilitate the movement of supplies into the Colony. The secondary phase may similarly be developed by the introduction of new equipment, construction of new markets, improvement of methods of handling fish and conducting the business, and by other such methods. But since there are so many possibilities it is by no means easy to lay down a master plan; moreover, as must be obvious, a choice among a number of alternatives may be correctly made only in the light of reliable information on the existing situation and on reasonable grounds of expectation of the results of the action which is contemplated.

It must be recognised that the fishing industry of the Colony is only imperfectly understood, and although in respect of information on this industry the Colony is more fortunate than most countries and territories of the Indo-Pacific region, nevertheless the Colony stands in need of much more information concerning its fishing industry, a point which becomes clear when any critical questions are posed concerning the industry. Certain general features of the industry are well enough known, as indicated in the following section, but when it is desired to proceed to considerations in quantitative terms, as a basis to planning development, it is found that information is either lacking or unreliable. Whilst it is clear that certain experimental measures can be taken on the basis of general information and by reference to experience elsewhere one would, however, hesitate to plan, for instance, new market premises in the absence of detailed information on the quantities of fish to be handled. On the other hand, it is not intended to imply either that action should await the accumulation of complete and fully reliable data, or even that the data must be complete and reliable to the last detail. Some kinds of action may be based on fairly general information whilst others require a greater degree of precision. Again, the actual progress of certain enquiries makes possible various types of action which themselves yield information.

From what has been said, it will be clear that the basis to the Department's programme should be a continuing system of collection and analysis of statistical and other data to provide an accurate and reliable description of the industry. In view of the urgency of the situation in the Colony this phase, which in certain countries outside the region is the normal and unremarked basis to the administrative programme, became the subject of a special survey. The survey has been in progress now for nearly a year and during that time has

COLONY OF SINGAPORE, FISHING VILLAGES & MARKETS.



accumulated much material and has several times been reorientated to the results obtained. Already substantial progress has been made and sufficient data have been accumulated to permit of a continual revision of departmental plans of action to assist and develop the industry. The purpose of this report is to describe the steps which have been taken so far to secure reliable documentation of the industry, and in particular to give an account of the statistical techniques employed to achieve a measure of reliability that will permit confident planning.

1.2 BRIEF DESCRIPTION OF THE INDUSTRY

During 1949, 10,163.9 tons of fresh fish were auctioned in the three wholesale markets in the Colony of Singapore. In the preceding years slightly smaller quantities had been handled and there was every reason to believe that supplies would continue to increase (Table I). Unfortunately, the political changes in Indonesia had a marked effect on supplies from that area during 1950 as a result of which imports showed a marked decline, particularly during the last few months of that year. Of the total supplies in 1949 approximately 23.5 per cent was produced by local fishing operations and the remainder was imported from adjacent territories of Malaya, Indonesia and Borneo, together with a little production by powered fishing vessels based on this Colony. In the past twenty years there have been considerable changes in the relative importance of these various sources of supply, as will be seen from the discussion in Section 4.2 and this constitutes a most important feature of the industry.

The local production is obtained from the work of more than 3,000 fishermen (Table II) operating 1,590 non-powered fishing vessels; there are approximately 200 powered vessels which are, however, of the carrier type and as such vessels rarely engage in fishing operations it is clear that the 1,400 persons employed on them do not contribute to fishing activity (Table III). The fishing operations involve the use of fishing stakes, drift nets (rarely exceeding 200 fathoms in length), beach seines, portable traps, handlines and a variety of other gears of lesser importance. All of these gears are operated in in-shore waters (Table IV): wider ranging fishing operations are hindered by the aforementioned geographical and political factors. Thus, to the south, the adjacent and interlacing territorial waters of the Riouw Archipelago, in which fishing by non-residents is restricted, prove an effective barrier; the open seas to the east are hazardous to vessels of the size at present employed in the industry during the north-east monsoon, and the Straits of Malacca to the west and north are heavily fished by the fishermen of Indonesia and the Federation of Malaya. In addition to the marine operations, there are some capture and culture operations in brackish water ponds (Table V) and extensive and important culture operations in freshwater ponds.

The local fishermen are located in about forty-two major centres placed around the island and on adjacent islands of the Colony (see Figure 1 and Table VI). These centres constitute natural collection points to which catches are brought and from which they are sent to markets.

The imported supplies are drawn from adjacent territories as shown in figure 2, and in some cases these supplies are characterized by strong seasonal fluctuation. Generally all are characterized by strong compositional and quality grouping.

Whilst the imported supplies are mostly landed at the auction markets, the local supplies are landed at numerous centres and are brought to markets by land and by sea.

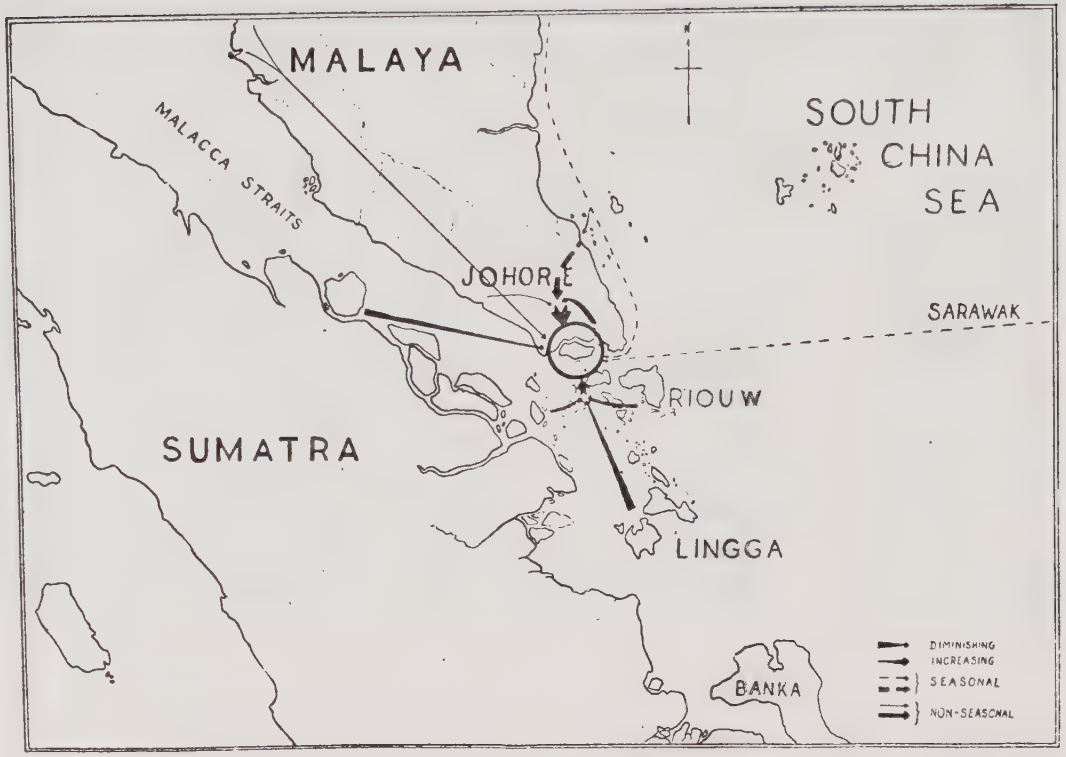


Figure 2. Movements of Fresh Fish Supplies to Singapore

The marketing organization consists of three wholesale markets (two Municipal and one private), two auction points and thirty-three major retail markets. Apart from this there are meat shops within the Municipal Area which also sell fish and itinerant hawkers of undetermined number, who are employed in both the Municipal and Rural areas. The arrangements for handling supplies in these markets, and the charges made, vary considerably. There are some cold storage facilities but relatively little use is made of them. The transport facilities consist of carrier vessels, lorries, cars and cycles.

The foregoing features are described in fuller detail in previous publications among which special reference is made to the Report of the Fisheries Department, Malaya, for 1949. At this stage it may be said that whilst these earlier accounts are admirable in their way they are quite inadequate for the purposes for which the present survey has been planned. These earlier reports do, however, provide the information from which to design the detailed survey.

1.3 THE USE OF STATISTICAL METHODS IN THE SURVEY

Although, as indicated above, much is already known of the fishing industry of Singapore, this information is, for the most part, of qualitative character and it is not always possible to evaluate the quantitative data which are available. The objective of the survey is to assemble an authoritative account of the industry which will serve as basis to a programme of management and development. And since the principal deficiency which the survey will fill must be in respect of quantitative information, it will be clear that statistical methods should play an important role. It is the purpose of this paper to indicate the nature of the role to be played by statistical methods and it is possible to commence by setting out a series of questions, such as the following, which must be answered by the survey before planned intervention in the industry may be effectively undertaken:—

(1) What are the main features of the Singapore fish supply? What is the general level of that supply, how much does it fluctuate at daily, weekly and longer intervals? Does it show any principal trend and any regular fluctuation which, being of sufficient constancy, might serve as the basis of predictions as to future supplies?

(2) Whence is the Singapore fish supply drawn, and what are the main statistical features of each of the separate parts of the supply, following the above series of questions?

(3) What is the specific composition of the Singapore fish supply and may the supply of the separate species be treated in the same way as the total and the locality subtotals?

(4) In respect of each of these divisions of the Singapore fish supply, what are the factors which determine the features? It is accepted that there is likely to be less discovered about the factors affecting imported supplies than about the locally produced supplies. Whatever the amount of information found, do the results suggest any measures which may be taken to improve these supplies through the factors revealed? Among these factors are considered the economic ones of costs of production, returns to fishermen and so forth.

(5) What are the main, statistical features of the organization for marketing and distribution of fish? Does the organization function efficiently?

(6) What are the prevailing prices for different types and classes of fish and what are the factors determining these; above all, what is the influence of volume of supply on price?

The value of the answers to these questions can be indicated as follows. First it is to be understood that the ultimate objective, beyond the achievement of an understanding of the industry, is to place Government, and the industry itself, in a position to enable the industry most effectively to discharge its proper function toward the community of which it is a part, namely to provide the community with the quantities of the fish of various types which it requires, at prices appropriate to the prevailing economic conditions of the community. The first thing that the survey can do is to show whether the industry does this

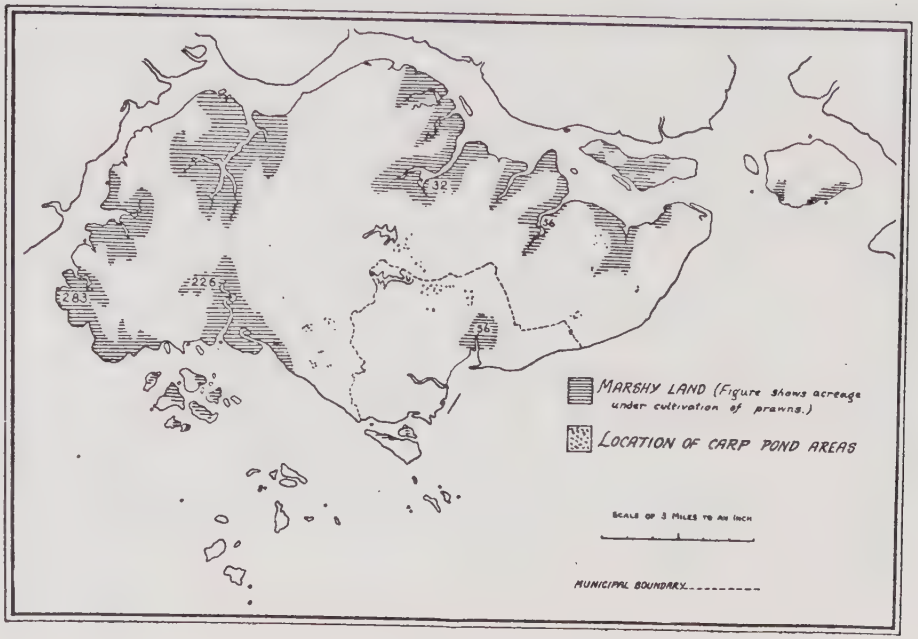

COLONY OF SINGAPORE, CULTURAL OPERATIONS.
32
226
283
56
MARSHY LAND (Figure shows acreage under cultivation of prawns.)
LOCATION OF CARP POND AREAS
SCALE OF 3 MILES TO AN INCH
MUNICIPAL BOUNDARY

Figure 3

at present and, since it is clear that it does not, how far and in what way it fails. This means that the survey must make the detailed analysis of supply and prices indicated in the above series of questions. Next, the survey should seek to furnish information which can be used to guide action to improve the situation: in this connection there are two major considerations to be kept in view, firstly the *level* of supplies (meaning not only the total of supplies available, but also the level of each of the different components of supply, as for example, the different species, the different size groups, and so forth); and secondly, the *fluctuation* of the level. The importance of knowing these relates on the one hand to the closeness with which the industry meets its demand and, on the other hand, to the task of ensuring the availability of facilities to handle these supplies.

The average level of supply may be related to the calculated level of demand and it is known that the latter is, for Singapore, far above the former; then from day to day and from month to month the supply fluctuates so that at times it falls a long way further below, and at other times approaches and perhaps exceeds the effective demand; thus there is presented the two-fold problem, first, of bringing the average level closer to the calculated requirement, second of reducing the amplitude of the fluctuations so that the ill-effects of unsatisfied demand and of excessive supply may be reduced. Solution of this double problem will involve many types of action in both primary and secondary phases of the industry; and will require action by both Government and the industry. There are many kinds of action which may be taken to increase the supplies; action, that is, to increase production, to increase the movement of supplies to the market, and to reduce the losses which take place between catching and delivery at the market. It will be obvious that an effective analysis of the present supply position will furnish guidance as to where action will most likely secure results. Thus the detailed analysis of the landings according to the localities from which the supplies are drawn, and the species and size groups of which the supplies are composed, will give pointers to scientific and technological investigations, experiments and developments. And the maintenance of such an analytical series continuously in time, with appropriate techniques, will not only show without delay whenever a significant change takes place in the situation, but may give an indication of the nature of the cause of the change and of the action which might appropriately be taken to remedy such a change, if unfavourable, or ensure its continuance if favourable. Thus, if the supplies of a particular type of fish should begin to decrease, the appropriate statistical control methods would detect such a tendency as soon as it became a significant departure from past experience, and would detect it much more quickly than it could be recognized by more simple observational methods; in addition, these techniques may point to the political, economic, technological or biological factors which might be responsible and in respect of which either investigations could be undertaken or practical administrative or other measures taken to remedy the situation.

Similarly, the statistical techniques can be a powerful instrument for guiding action in respect of secondary facilities. The measurement, as accurately as possible, of the average level of supply and of the average fluctuation is an indispensable preliminary to any programme for the provision of transport. market premises, market organization, storage facilities and processing facilities. Beginning with market premises, it is obvious that these should have capacity at least equal to the average level of supply—that is, enough floor space, containers, trolleys and so forth to be able to handle the average level with a minimum of delay, and should have staff for such capacity to work at a set minimum pace. Then provision should be made for coping with supply which exceeds the average level, or for effective intervention when the supply

falls a determined degree below the average. Storage facilities of various types and capacities should be available, or procurable, to cope with various grades of excess and should be graduated up to the maximum situation of glut for which emergency measures should be planned and be capable of adoption without delay. Conversely, suitable administrative measures should be designed for using facilities and staff during periods of under-supply. It is obvious that a system which can analyse supply and furnish a workable picture of its behaviour, indicating the rhythms, the times of maximum and of minimum, and the height and duration of these can contribute greatly to effective planning of these facilities, and this is true of course for the whole of the equipment for the secondary phase.

It is of course unlikely that this industry should remain unchanged over a period of years; it is more likely that it should exhibit a secular trend and that the supplies should continue to increase with the increase in population and the improvement in living standards. It is possible that even the fluctuation pattern might exhibit a secular trend of change. In any case it may be expected that changes will occur and that provision should be made to cope with them. The maintenance of a statistical series with proper analysis will reveal such changes as soon as they occur and, as far as the planning of facilities is concerned, the inspection of properly prepared diagrams and figures will furnish a useful basis for calculations as to the appropriate capacity of facilities to be provided.

From what has just been said it will be clear that the answers to the questions on page 5 must, to be useful for the present purposes, be in quantitative form and that statistical methods must be employed generally throughout the survey programme. These methods will be required in the beginning in designing the collection of data and in directing that phase of the programme; the second phase, namely of compilation of collected data, must integrate closely with the collection phase: there must be a speedy system of tabulation and presentation in graphical and other form. The significance of this rapid early stage of assembling the collected data is that the statistical workers should thereby be enabled to recognise defects, or major phenomena, with a minimum of delay. Statistical methods must be employed to assess the value of the information being gathered and to determine where and how the pressure of the field work may need to be redirected—relieved in some places, intensified in others. However, these are in fact the preliminary stages: there follow the stages of analysis and interpretation. In the analytical stage various essential properties of the statistical series will be isolated and accurately measured, such as the mean handlings in unit period. In the interpretational stage the relationship between series must be measured and the significance of the statistical properties determined: in this stage the statistical methods become essentially an instrument in the hands of the other technical workers who make the determination of significance in terms of the biological or other factors involved. The application of confidence limits, the choice of levels of significance, and the decision on degree and extent of extrapolation, demand a nice adjustment between statistical and other techniques. It is probable that neither might yield a definitive answer without the other.

To recapitulate, the statistical work falls into the following sequence of phases:—

Collection; Compilation; Analysis; Interpretation,

none of which is independent since, in proceeding along the sequence the work in one phase is determined by the material which comes from that before it, and conversely, the results in one may have considerable bearing on the continuance of the work in those before it.

At this point it is perhaps advisable to emphasise for the benefit of those readers who have no statistical training that none of the methods employed here is novel in itself. All of the methods are to be found in standard texts on economic and other types of statistical practice. There is perhaps some novelty in the application of some of these methods in fishery work: it is thought that a range of methods such as is employed here has not hitherto been employed in a similar comprehensive plan of attack upon a single fishing industry. And it is thought that the publication of this account will serve not only to inform the responsible authorities of the type of work which is being done in respect of this section of the Colony's economy but will be a useful statement of experience as a guide to other workers in this field. In the following pages the description of the statistical methods is made on the following plan. The collection work is first discussed and it has been necessary to present a statement of the industrial framework in respect of which the statistics are to be collected. This is followed by an account of the methods employed in collecting statistics with reference to this framework, the staff employed and the forms which they use. An indication is also given of the deficiencies of this collection programme. In the next section an inventory is given of the statistical series, terminated and current, which are available: this constitutes a report of the compilation phase of the work. There then follows an account of the methods which may be employed in treatment of these series. Of necessity this section describes selected methods, the selection having been made with regard to the general objectives of the survey. It would be possible to employ various other techniques, making different approaches to the material, but it is the purpose of this paper to indicate methods which are appropriate to the material and the objectives of the survey. This section is in the main concerned with the analytical phase of the programme; it inevitably contains interpretational elements, but the main interpretational section is the fourth, which indicates the approach which may be made to test the results which come from the analytical work and the interpretations which are open to the investigator. In the final section, entitled Discussion, an attempt is made to draw conclusions, from the results obtained in the earlier sections, as to the continued use of these methods: it is clear that statistical control should be continued, but the question lies as to how much of the possible machinery of collection and analysis should be maintained, and it is just as important to prevent excessive labour in this work, as to prevent insufficient or ineffective work.

Table I

WET FISH HANDLINGS IN MUNICIPAL AND PRIVATE AUCTION MARKETS FOR YEARS 1947 TO 1950

(Weights in tons: 1 ton = 2,240 lb. = 16.8 piculs)

Area of Origin	1947		1948		1949		1950												TOTAL	
	Tons	Per cent	Tons	Per cent	Tons	Per cent	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Tons	Per cent
REPUBLIC OF INDONESIA																				
RIOUW AND VICINITY																				
Karimoen Group ..	732.2	7.7	903.9	9.4	850.7	8.4	54.5	53.9	74.3	74.2	50.3	54.1	55.3	51.7	48.8	56.2	37.5	43.0	653.8	6.4
Batam	899.8	9.5	709.4	7.4	814.8	8.0	65.4	58.0	53.6	53.0	49.5	59.6	50.0	45.9	39.6	53.4	54.2	78.9	661.1	6.5
Lingga	542.2	5.7	681.8	7.1	457.0	4.5	33.1	52.7	33.1	34.1	47.3	73.3	63.8	62.9	46.7	44.7	42.0	49.7	583.4	5.8
TOTAL, RIOUW AND VICINITY	2,174.2	22.9	2,295.1	23.9	2,122.5	20.9	153.0	164.6	161.0	161.3	147.1	187.0	169.1	160.5	135.1	154.3	133.7	171.6	1,898.3	18.7
Sumatra	1,706.6	18.0	977.4	10.2	555.5	5.5	42.7	33.6	25.6	17.6	13.0	8.9	5.8	17.4	22.4	15.0	8.3	15.6	225.9	2.2
Other Islands ..	1.8	..	128.6	1.3	116.5	1.1	..	..	1.6	0.5	3.5	13.8	16.5	22.7	25.1	3.2	2.0	2.0	90.9	0.9
TOTAL, REPUBLIC OF INDONESIA ..	3,882.6	40.9	3,401.1	35.4	2,794.5	27.5	195.7	198.2	188.2	179.4	163.6	209.7	191.4	200.6	182.6	172.5	144.0	189.2	2,215.1	21.8
FEDERATION OF MALAYA																				
JOHORE																				
West	231.3	2.4	153.6	1.6	126.7	1.2	23.4	14.7	23.2	6.7	9.2	4.8	8.3	5.5	4.2	5.4	5.4	28.1	138.9	1.4
East	956.7	10.1	1,249.0	13.0	1,712.9	16.8	4.0	10.2	21.0	180.0	327.7	312.9	261.1	350.7	313.6	344.7	150.1	23.9	2,299.9	22.6
South	1,725.1	18.2	2,037.8	21.2	2,634.7	26.0	220.0	190.6	233.8	235.5	230.0	219.2	91.0	65.0	72.8	68.8	68.4	105.8	1,800.9	17.7
TOTAL, JOHORE ..	2,913.1	30.7	3,440.4	35.8	4,474.3	44.0	247.4	215.5	278.0	422.2	566.9	536.9	360.4	421.2	390.6	418.9	223.9	157.8	4,239.7	41.7
WEST COAST MALAYA (Excluding Johore)																				
Kedah	1.0	..	20.0	..	12.5	..	17.5	17.3	45.5	4.1	4.0	2.1	..	..	1.6	..	14.8	12.6	119.5	..
Penang	318.6	..	315.4	..	115.9	..	3.7	7.9	24.4	21.2	6.4	..	1.3	2.2	0.6	..	..	..	67.7	..
Perak	25.3	..	39.2	..	157.0	..	89.0	52.1	12.1	11.1	4.6	0.4	0.8	..	..	1.4	18.8	41.7	232.0	..
Selangor	36.8	..	30.1	..	24.8	..	..	..	..	..	..	..	..	..	1.8	..	2.1	0.4	4.3	..
Negri Sembilan ..	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Malacca	55.7	..	43.2	..	37.7	..	0.9	0.6	0.6	0.9	0.3	1.7	..	..	..	..	0.5	2.1	7.6	..
	437.6	4.6	447.9	4.7	347.9	3.4	111.1	77.9	82.6	37.3	15.3	4.2	2.1	2.2	4.0	1.4	36.2	56.8	431.1	4.2

Table I—*continued*

WET FISH HANDLINGS IN MUNICIPAL AND PRIVATE AUCTION MARKETS FOR YEARS 1947 TO 1950—*continued*

(Weights in tons: 1 ton = 2,240 lb. = 16.8 piculs)

Area of Origin	1947		1948		1949		1950												TOTAL	
	Tons	Per cent	Tons	Per cent	Tons	Per cent	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Tons	Per cent
EAST COAST MALAYA (Excluding Johore)																				
Kelantan	16.7	..	1.5	..	..	..	..	1.0	2.6	2.9	1.0	..	..	..	..	..	..	..	7.5	..
Trengganu	1.2	..	14.4	..	2.2	..	..	..	..	3.8	0.5	..	1.2	8.3	14.5	17.1	0.8	0.3	46.5	..
Pahang	9.7	..	17.2	..	27.2	..	..	..	..	1.0	3.6	9.6	8.2	5.1	4.7	..	2.6	0.1	34.9	..
	27.6	0.3	33.1	0.3	29.4	0.3	..	1.0	2.6	7.7	5.1	9.6	9.4	13.4	19.2	17.1	3.4	0.4	88.9	0.9
TOTAL, FEDERATION OF MALAYA (Excluding Johore)	465.2	4.9	481.0	5.0	377.3	3.7	111.1	78.9	85.2	45.0	20.4	13.8	11.5	15.6	23.2	18.5	39.6	57.2	520.0	5.1
TOTAL, FEDERATION OF MALAYA (Including Johore) ..	3,378.3	35.6	3,921.4	40.8	4,851.6	47.7	358.5	294.4	363.2	467.2	587.3	550.7	371.9	436.8	413.8	437.4	263.5	215.0	4,759.7	46.8
SARAWAK	4.3	..	9.2	0.1	118.5	1.2	..	..	..	1.2	7.1	9.0	10.1	19.3	14.5	23.6	9.8	2.2	96.8	1.0
BRITISH NORTH BORNEO ..	..	..	..	..	..	..	..	..	..	..	..	..	2.5	1.4	..	..	..	..	3.9	..
THAILAND	17.0	0.2	2.6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
BURMA (Rangoon) ..	..	..	18.3	0.2	30.2	0.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..
INDIAN OCEAN ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1.8	5.0	6.8	..
LOCAL	2,209.0	23.3	2,255.4	23.5	2,369.1	23.3	218.8	213.7	240.1	222.0	209.2	191.5	227.8	223.6	240.7	253.2	457.2	399.1	3,096.9	30.4
GRAND TOTAL ..	9,491.2	100.0	9,608.0	100.0	10,163.9	100.0	773.0	706.3	791.5	869.8	967.2	960.9	803.7	881.7	851.6	886.7	876.3	810.5	10,179.2	100.0
AVERAGE PER DAY ..	26.0	..	26.3	..	27.8	..	24.9	25.2	25.5	29.0	31.2	32.0	25.9	28.4	28.4	28.6	29.2	26.1	27.9	..

Table II

INVENTORY OF FISHERMEN, 1947–1950

Race	1947	1948	1949		1950
			Licensed	Estimated Number	
1. Licensed Fishermen:—					
Chinese	2,492	3,142	3,073	3,144	3,339
Malays	1,251	1,170	1,301	1,588	1,609
Indians	7	5	10	10	16
Other Races	11	2	3	3	3
	3,761	4,319	4,387	4,745	4,967
2. Net-Menders (Estimated):—					
Chinese	50	50	..	150	150
Malays	15	15	..	15	15
	65	65	..	165	165
3. Erectors of Fishing Stakes (Estimated):—					
Chinese	64	64	..	64	64
Malays	40	40	..	40	40
	104	104	..	104	104

Table III

INVENTORY OF LICENSED FISHING BOATS, 1947–1950

A. Number and Types of Boats Licensed.

Type of Boat	1947	1948	1949	1950
Power-propelled boat	229	267	231	196*
Koleh Chiau	371	368	439	518
Koleh (Johore *Koleh*)	549	574	556	642
Sampan (*Koleh Selat*)	280	327	382	521
Kotak 1. *Kwah Tow*	..	..	..	2
Kotak 2. *Tiang Pang Tow*	..	..	..	12
Kotak 3. For Repairs and Erection of Stakes ..	30	40	40	8
Kotak 4. *Jala*	..	..	..	22
Kotak 5. For *Sagai* Fishing	..	..	..	1
Jalor	55	62	61	80
Boat	13	14	10	13
Jongkong	2	1	2	1
Lepap	1	..	..	..
Moro-ami Sampan	..	..	..	8
Pukat Jerut Sampan (*Beng Thenk*)	..	..	..	3
Total ..	1,530	1,653	1,721	2,027

*Includes twenty-seven licences which were subsequently cancelled.

Table III—*continued*

INVENTORY OF LICENSED FISHING BOATS, 1947–1950—*continued*

B. Details of Power-propelled Fishing Boats as on 31st December, 1950.

Length of Boat				Total No. of Fishing Boats	Tonnage*				HORSE POWER				
									Outboard		Inboard		
Under 25 feet	25 to 40 feet	40 to 65 feet	Over 65 feet		Under 15 tons	15 to 30 tons	30 to 45 tons	45 to 75 tons	Under 10 H.P.	10 to 20 H.P.	Under 25 H.P.	25 to 50 H.P.	Over 50 H.P.
14	96	58	1	169	115	39	15	..	13	2	77	45	32

*Tonnage formula – Length × breadth × depth × :0045.

C. Type of Engine as on 31st December, 1950.

Oil engines			Petrol Inboard			Petrol Outboard		Total
Country of Manufacture	Number		Marine Engines	Converted Motor Car/Lorry Engines	Petrol/Paraffin Engines	British Manufacture	Others	
United Kingdom	7							
Germany	5							
Japan	119							
Holland	2							
Others	5							
	138		1	15	3	1	11	169

D. Utilisation of Powered Vessels in Fishing Industry as on 31st December, 1950.

Fish-Carriers							Tenders	
Fish Carriers only	Fish Carriers and *Moro ami*	Fish Carriers and Trolling	Fish Carriers and *Sagai* Fishing	Fish Carriers and *Jaring*	Fish Carriers and *Rawei Umpan*	Fish Carriers and Floating Trawl	For Towing *Nihongs*	For Erection and Repair of Fishing Stakes
127	6	17	3	5	2	1	3	5

E. Areas covered by Powered Vessels in Fishing Industry as on 31st December, 1950.

Inside 30 mile radius	Coastal	Deep Sea
18	114	37

Table IV

INVENTORY OF FISHING GEARS, 1948–1950

Type of Fishing Gear	No. of Fishing Gears Licensed		
A. Licensed	1948	1949	1950
Kelong in depth exceeding 3 fathoms	126	139	132
Kelong in depth not exceeding 3 fathoms	108	108	116
Belat (Shallow-water stake) (*a*) Using lift-net ..	29	95	21
(*b*) Using dip-net ..			81
(*c*) Using *bubu* ..			14
Pukat Tarek (Beach seine)	67	62	77
Prawn Pond Net	177	188	196
Moro-ami (Drive-in net)	3	4	3*
Pukat Gonggong (Inshore pair trawl)	1	1	5
Pukat Payang (Singapore sunken boat-seine) ..	2	4	4
Pukat Jerut (Purse seine net)	..	..	1
Floating Trawl	..	..	2
Jaring Hanyut (Drift net)	250	281	255
Jaring Selangat (Drift net)	5	6	13
Jaring Ketam (Crab tangle-net)	15	16	24
Jaring Karang (Reef staked gill-net)	1	2	11
Jaring Tenggelam (Sunken gill-net)	..	..	2
Tangkul (Lift net)	14	15	15
Sondong (Push net)	31	55	31
Rawai Umpan (Baited long-line)	19	29	36
Bubu (portable fish-pot) (deep-water)	..	..	24
(ordinary)	97	255	106
(coral)	..	..	17
Bubu Empang (Fish-pot with wings)	23	29	6
Bintur (Crab lift net)	1	2	5
Injap (Baited crab pot)	6	8	17
Empang (Set barrier)	..	..	15
Total ..	975	1,299	1,239
B. Exempt from Licensing Regulations			
Pelontang (Floated single-line)	100	250	250
Hand-lines	300	800	800

*Only two in active operation during 1950.

Table V

INVENTORY OF CULTURAL OPERATIONS

(ESTIMATED, 1949)

A. Prawn Culture

Seletar Area

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	1	1	1	..	3
Number of Nets ..	1	4	3	..	8
Acreage utilised ..	2	10	20	..	32
Total yearly production per acre in katties ..	600	480	60	..	..

Estimated Total Production per year = 7,200 katties (4.3 tons).

Tampenis-Serangoon Area

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	..	3	2	..	5
Number of Nets ..	..	7	6	..	13
Acreage utilised ..	..	21	35	..	56
Total yearly production per acre in katties ..	..	132.6	..	..	..

Estimated Total Production per year = 2,800 katties (1.67 tons).

West Coast Road (8–10 *Miles*)

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	17	15	7	1	40
Number of Nets ..	40	42	32	7	121
Acreage utilised ..	47.75	97.5	113.5	25	283.75
Total yearly production per acre in katties ..	876	474	280	254.4	..

Estimated Total Production per year = 126,000 katties (75 tons).

Table V—*continued*

INVENTORY OF CULTURAL OPERATIONS—*continued*

Jurong Road Area (14–16 *Miles*)

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	..	7	2	3	12
Number of Nets ..	..	33	11	12	56
Acreage utilised ..	..	54	32	140	226
Total yearly production per acre in katties ..	..	900	506.25	125.3	..

Estimated Total Production per year=82,200 katties (48.9 tons).

Kallang River (*Near Geylang*)

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	2	5	1	..	8
Number of Nets ..	3	8	2	..	13
Acreage utilised ..	7.5	31	18	..	56.5
Total yearly production per acre in katties ..	288	430	333.33	..	..

Estimated Total Production per year=21,500 katties (12.8 tons).

Total Singapore

	Under 5 acres	5–10 acres	10.1–20 acres	Over 20 acres	Total
Number of Ponds ..	20	31	13	4	68
Number of Nets ..	44	94	54	19	211
Acreage utilised ..	57.25	213.50	218.50	165.00	654.25

Estimated Total Production per year=239,700 katties (142.67 tons).

B. Carp Culture

Estimated Acreage Utilised =300 acres.

INVENTORY OF FISHERMEN, BOATS AND GEAR BY AREA, 1950

A. Fishermen and Boats

No.	Name of Fishing Village	NUMBER AND RACE OF FISHERMEN					NUMBER OF FISHING BOATS	
		Malays	Chinese	Indians	Others	Total	Non-powered	Powered
1	Town Area (i)	3	121	1	..	125	52	..
	(ii)*	30	1,201	..	1	1,232	..	152
2	Kallang Area (including Pulau Minyak and Geylang)	10	152	..	..	162	74	..
3	Katong	28	136	..	..	164	81	..
4	Kampong Amber	3	6	..	..	9	9	..
5	Kampong Siglap (including Frankel Estate)	11	139	..	..	150	86	1
6	Kampong Bahru (Siglap)	28	97	..	..	125	48	..
7	Kampong Bedok	11	22	..	..	33	26	..
8	Kampong Padang Terbakar	74	124	..	..	198	145	1
9	Kampong Telok Mata Ikan	..	88	..	..	88	42	..
10	Kampong Ayer Gemuroh (including Tanah Merah Besar)	54	5	..	..	59	48	..
11	Kampong Changi	33	2	..	..	35	26	..
12	Pulau Ubin	25	33	1	..	59	42	..
13	Pulau Tekong (including Tekong Kechil)	232	150	..	..	382	230	..
14	Kampong Loyang	34	13	..	..	47	26	..
15	Upper Serangoon	15	66	2	..	83	33	..
16	Ponggol Area	16	202	..	..	218	91	..
17	Seletar (including Tanjong Irau and Sungei Seletar)	21	80	..	..	101	39	..
18	Choa Chu Kang	..	4	..	..	4	2	..
19	Tuas	..	144	..	..	144	123	4
20	Tanjong Kling	75	8	2	..	85	49	..
21	Pulau Semulun	91	5	2	..	98	55	..
22	Kampong Damar Darat	21	1	..	..	22	12	..
23	Pulau Damar Laut	33	8	2	..	43	20	2
	Carried forward ..	848	2,807	10	1	3,666	1,359	160

*Powered fishing boats.

Table VI—*continued*

INVENTORY OF FISHERMEN, BOATS AND GEAR BY AREA, 1950—*continued*

A. Fishermen and Boats

No.	Name of Fishing Village	NUMBER AND RACE OF FISHERMEN					NUMBER OF FISHING BOATS	
		Malays	Chinese	Indians	Others	Total	Non-powered	Powered
	Brought forward ..	848	2,807	10	1	3,666	1,359	160
24	Pulau Seraya	77	8	..	..	85	42	2
25	Pulau Merlimau	30	4	..	..	34	17	..
26	Pulau Ayer Merbau	11	3	..	..	14	6	1
27	Pulau Ayer Chawan	5	2	..	..	7	4	..
28	Pulau Pesek	4	4	..	..	8	4	..
29	Tanjong Penjuru	44	3	..	..	47	26	..
30	West Coast Road Area (from 7 m.s. to Sungei Jurong) ..	55	31	..	..	86	38	..
31	Pasir Panjang 6 m.s.	..	63	..	..	63	33	..
32	Pasir Panjang 5½ m.s.	4	42	..	..	46	25	2
33	Pulau Bukom Besar	20	2	..	.	22	11	..
34	Pulau Bukom Kechil	79	17	..	..	96	48	..
35	Pulau Semakau	83	22	..	..	105	52	2
36	Pulau Seking	40	2	..	..	42	23	..
37	Pulau Sudong	86	7	..	..	93	51	1
38	Pulau Pawai (including Pulau Senang)	4	7	..	2	13	8	1
39	Pulau Sekijang	90	6	..	..	96	37	..
40	Telok Belangah	9	..	..	..	9	6	..
41	Pulau Brani	42	23	..	..	65	32	..
	Total ..	1,531	3,053	10	3	4,597	1,822*	169*

*Do not include boats which were subsequently cancelled.

INVENTORY OF FISHERMEN, BOATS AND GEAR BY AREA, 1950—*continued*

B. Gear

No.	Name of Fishing Village	Pukat Tarek	Prawn Pond Net	Moro ami	Pukat Gonggong	Pukat Payang	Pukat Jerut	Floating Trawl	Jaring Hanyut	Jaring Selangat	Jaring Ketam	Jaring Karang	Jaring Tenggelam	Tangkul	Sondong	Rawai Umpan	Bubu Laboh	Bubu Ordinary	Bubu Karang	Bintur	Enjab	Empang	Bubu Empang	Shell-Fish	Total
1	Town Area	..	..	..	..	..	..	..	11	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	12
2	Kallang Area (including Pulau Minyak and Geylang)	7	16	..	..	..	..	..	15	..	1	..	..	..	..	3	..	..	..	1	..	..	..	..	43
3	Kampong Amber	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4	Katong Area	2	..	..	..	..	..	..	18	..	..	..	..	..	1	1	1	..	..	..	..	..	..	..	23
5	Kampong Siglap (including Frankel Estate)	1	..	..	5	4	..	..	32	..	1	..	..	..	12	1	..	1	..	..	..	..	..	..	57
6	Kampong Bahru (Siglap)	10	..	..	..	..	1	..	2	..	9	..	1	..	7	..	..	..	..	..	..	..	..	..	30
7	Kampong Bedok	..	..	..	..	..	..	..	..	2	..	..	..	..	4	..	..	..	..	..	..	..	..	..	6
8	Kampong Padang Terbakar	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	5	5	..	..	..	..	..	..	12
9	Kampong Telok Mata Ikan	4	..	..	..	..	..	..	..	9	..	..	..	..	4	..	..	..	..	..	..	..	..	..	17
10	Kampong Ayer Gemuroh	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	2	3	..	1	..	..	..	10
11	Kampong Changi	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	2	..	..	..	..	..	..	4
12	Pulau Tekong (Besar and Kechil)	5	..	..	..	..	..	..	..	1	..	..	..	3	..	10	..	16	1	..	..	1	..	..	37
13	Pulau Ubin	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	8	..	..	..	2	..	..	11
14	Upper Serangoon Area	6	..	..	..	..	..	..	..	..	1	..	..	2	..	..	..	..	..	..	2	4	..	..	15
15	Ponggol Area	22	..	..	..	..	..	..	2	..	10	..	..	1	..	4	..	5	..	4	..	4	..	..	52
16	Seletar Area (including Tanjong Irau and Sungei Seletar)	8	4	..	..	..	..	..	..	..	..	..	..	..	2	2	..	6	..	..	1	1	..	..	24
17	Kampong Woodland and Kranji	..	..	..	..	..	..	..	..	..	2	..	..	2	..	..	..	1	..	..	..	..	..	..	5
18	Lim Chu Kang	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
19	Choa Chu Kang and Bajau	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	2
20	Tuas	..	58	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	59
21	Pulau Semulun	..	..	..	..	..	..	..	15	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	16
22	Tanjong Kling	..	..	..	..	..	..	..	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7
23	Damar Laut and Damar Darat	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	7
24	Tanjong Penjuru	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	11	..	..	..	..	..	..	12
25	Sungei Jurong to West Coast Road Area	6	118	..	..	..	..	..	2	..	..	..	..	2	..	..	1	6	1	..	..	..	..	..	136
26	Pasir Panjang Area	..	..	..	..	..	..	..	36	..	..	..	..	..	..	..	1	2	..	..	..	..	..	..	39
27	Pulau Seraya	..	..	..	..	..	..	..	9	..	..	6	..	..	..	..	6	..	..	..	..	..	..	..	21
28	Pulau Ayer Chawan	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1
29	Pulau Ayer Merbau	..	..	..	..	..	..	..	7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7
30	Pulau Pesek	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1
31	Pulau Merlimau	..	..	..	..	..	..	..	6	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	7
32	Pulau Bukom Kechil	..	..	..	..	..	..	..	31	..	..	3	..	..	..	..	2	2	6	..	..	..	..	..	44
33	Pulau Semakuu	..	..	..	..	..	..	..	7	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	9
34	Pulau Seking	..	..	..	..	..	..	..	16	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	18
35	Pulau Sudong	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	13	..	..	..	..	5	..	22
36	Pulau Sekijang	..	..	..	..	..	..	..	27	..	..	..	..	..	..	..	..	3	..	..	..	..	1	..	31
37	Pulau Brani	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	8	..	..	..	..	..	..	9
38	Powered Fish Carriers	4	..	3	..	..	2	1	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	10*	22
39	Other Areas—(*a*) Johore	..	..	..	..	..	..	..	..	..	..	..	..	3	..	10	1	12	..	..	13	1	..	..	40
	(*b*) Indonesia	..	..	..	..	..	..	..	2	..	..	1	..	..	..	..	..	2	..	..	..	..	..	..	5
	Total	77	196	3	5	4	1	2	255	13	24	11	2	15	31	36	24	106	17	5	17	15	6	10	875

*Ten licences were issued for 142 men.

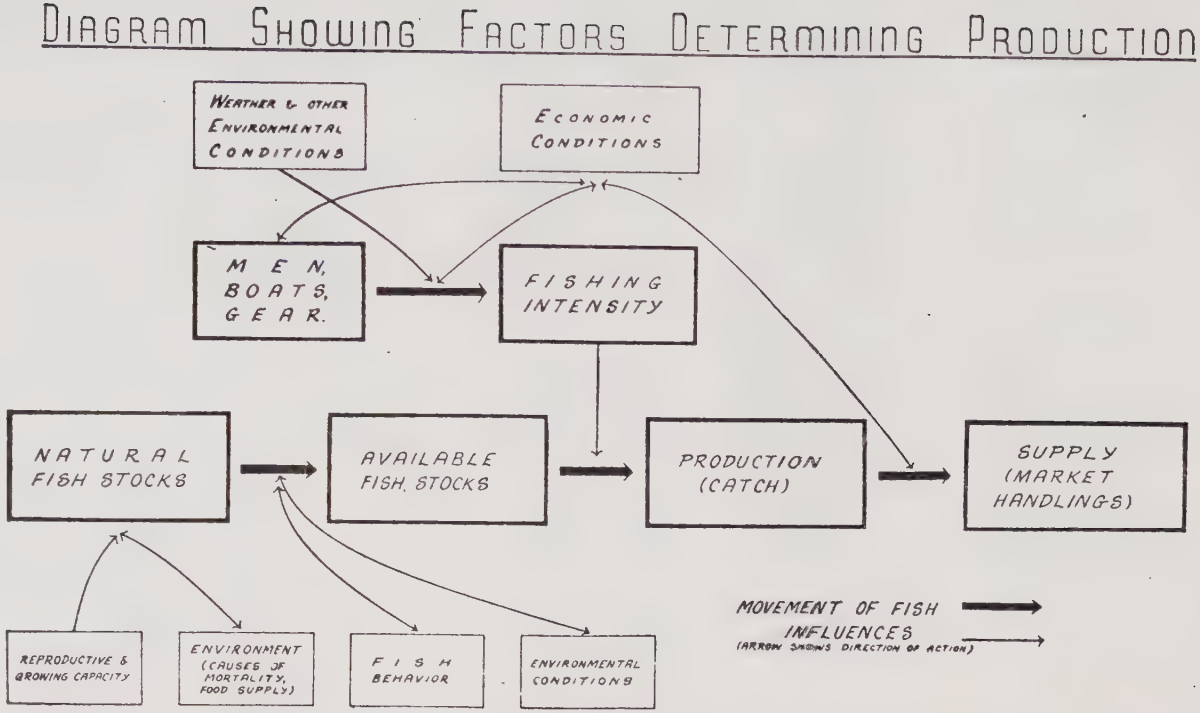


DIAGRAM SHOWING FACTORS DETERMINING PRODUCTION
WEATHER & OTHER ENVIRONMENTAL CONDITIONS
ECONOMIC CONDITIONS
MEN, BOATS, GEAR.
FISHING INTENSITY
NATURAL FISH STOCKS
AVAILABLE FISH. STOCKS
PRODUCTION (CATCH)
SUPPLY (MARKET HANDLINGS)
REPRODUCTIVE & GROWING CAPACITY
ENVIRONMENT (CAUSES OF MORTALITY, FOOD SUPPLY)
FISH BEHAVIOR
ENVIRONMENTAL CONDITIONS
MOVEMENT OF FISH
INFLUENCES
(ARROW SHOWS DIRECTION OF ACTION)

Figure 4

2. COLLECTION OF DATA

THE FIRST responsibility of the statistical worker, in a programme such as this, is to plan the collection of the data. This involves firstly a recognition of the main features of the system under investigation, identification of the principal elements, and specification of the best points at which data may be collected. It involves secondly a decision on the frequency of observation and, in respect of certain elements, on the proportion of the 'universe' which must be observed in order to obtain a reliable estimate of the universe itself. The two stages may be identified as (1) designation of a framework of collection, (2) design of a programme of collection.

2.1 FRAMEWORK OF COLLECTION

Consideration of figures 4, 5 and 6 will give an idea of the various elements in respect of which statistical collection must be made. A first separation must be made between the primary and tertiary phases of the industry, that is the production on the one hand, and the marketing and distribution on the other. Although there is some overlap of these phases, in the main there is such a clear distinction between the elements of each phase, the factors which influence them and their operation, that distinction between the two is a necessity. Within each there are four sets of material to be observed:—

(1) The elements of the industry.

(2) The operations of those elements.

(3) The results of the operation of those elements (production in the primary phase, supplies handled in the tertiary phase).

(4) The financial measure of the operations.

Although perhaps slightly illogical, it is practicable and desirable to establish a separate class to include data on prices.

The following tabulation gives a full list of the elements and factors in respect of which statistical data are required.

A. FACTORS OF PRODUCTION

Manpower
Equipment (Craft, Gear)
Finance

B. OPERATION OF THE FACTORS OF PRODUCTION

Frequency and duration of operation.

C. VOLUME OF PRODUCTION

Recorded as species or types, by intervals of time in geographic area units, according to type of gear by which taken.

D. COSTS OF PRODUCTION

Capitalization charges as per the inventory of factors of production recorded under A, and operating costs in accordance with the operations of the industry as recorded under B.

E. FACTORS OF DISTRIBUTION

Manpower
Equipment
Finance

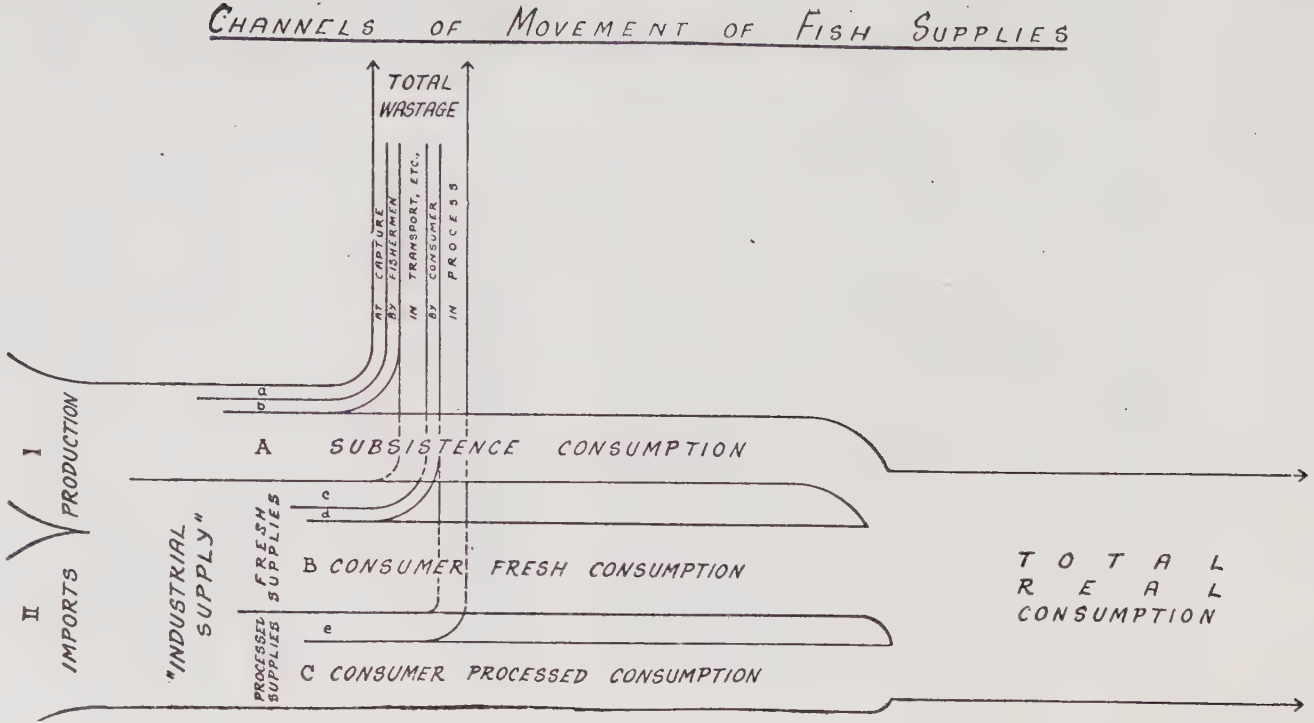

CHANNELS OF MOVEMENT OF FISH SUPPLIES
TOTAL WASTAGE
AT CAPTURE
BY FISHERMEN
IN TRANSPORT, ETC.
BY CONSUMER
IN PROCESS
a
b
A SUBSISTENCE CONSUMPTION
c
d
B CONSUMER FRESH CONSUMPTION
e
C CONSUMER PROCESSED CONSUMPTION
I PRODUCTION
II IMPORTS
"INDUSTRIAL SUPPLY"
FRESH SUPPLIES
PROCESSED SUPPLIES
TOTAL REAL CONSUMPTION

Figure 5

F. OPERATION OF THE FACTORS OF DISTRIBUTION

G. VOLUME OF SUPPLY AND MARKET OPERATIONS

H. COSTS OF DISTRIBUTION

I. PRICES

It is necessary to point out and to stress the difference between A, B and C, and again, between E, F and G. In highly organized industries the statistics of these groups are very largely taken in single operations; in the present instance this method is not so practicable. In the first place, it is necessary to take an inventory of the factors (or elements) of each phase of the industry and this, which is a simple enumeration of each of these elements in relation to some geographic or administrative frame, constitutes a listing of the units available to the industry with which to perform its operations. The actual use to which these units are put is another question altogether and introduces the time element and the idea of intensity of operation*. Considerations of efficiency, and of differences of efficiency between units of each category and between different categories, then arise. These considerations may in part be dealt with in relation to production (or to quantity of fish handled) since the amount produced (or handled) by a unit of equipment is some measure of its efficiency, *albeit* an inadequate and unreliable measure.

It is to be noted that the foregoing framework relates only to the structure and operation of the fishing industry itself and involves no collection of data concerning elements or factors external to the industry. However, other sets of data, collected by other agencies and for other purposes, will be referred to as serving to measure factors external to the industry which exercise an influence on its operation. These will include demographic information concerning the Colony, cost of living indices, industrial and trade indices and so forth. Also, information will be sought on the environmental factors which influence the fish stocks and the operation of the fishing gear.

Much of this framework is covered at present by the statistical section of the survey organization. Certain aspects of this work are commented on the following notes.

A. FACTORS OF PRODUCTION

(*a*) *Manpower*.—Considerable caution must be exercised in attempting an enumeration of persons engaged in the fishing industry. A common confusion is made between fishing population, in various senses, and the actual manpower available to the industry. The following are the principal groups into which the fishing population may be divided. For the purposes of analysing production at least groups 1 and 2 should be enumerated separately, even if the others might be enumerated together.

(1) Fishermen.
(2) Boat Crew.
(3) Net Makers
(4) Net Menders
(5) Erectors of Fishing Stakes
  (*a*) Experts
  (*b*) Skilled labourers
  } Gear and Equipment Makers.
(6) Village boat builders
(7) The dependents of 1 to 6 inclusive.

The foregoing are the occupational categories of the population. Further classification is possible on the basis of sex, age, religion, degree of wealth and so forth and it may be necessary to record such information in relation to different sections of the programme. In respect of an evaluation of manpower as a factor of production, any characteristic which may be expected to influence the contribution which the individual makes to production, should be taken into cognizance.

*'Fishing intensity' is a derivative term signifying number of units of standard fishing effort per unit time and must be distinguished from the amount of fishing effort which is the single statistical record of the operation of actual gear.

COLONY OF SINGAPORE. STRUCTURE OF FISHING INDUSTRY.

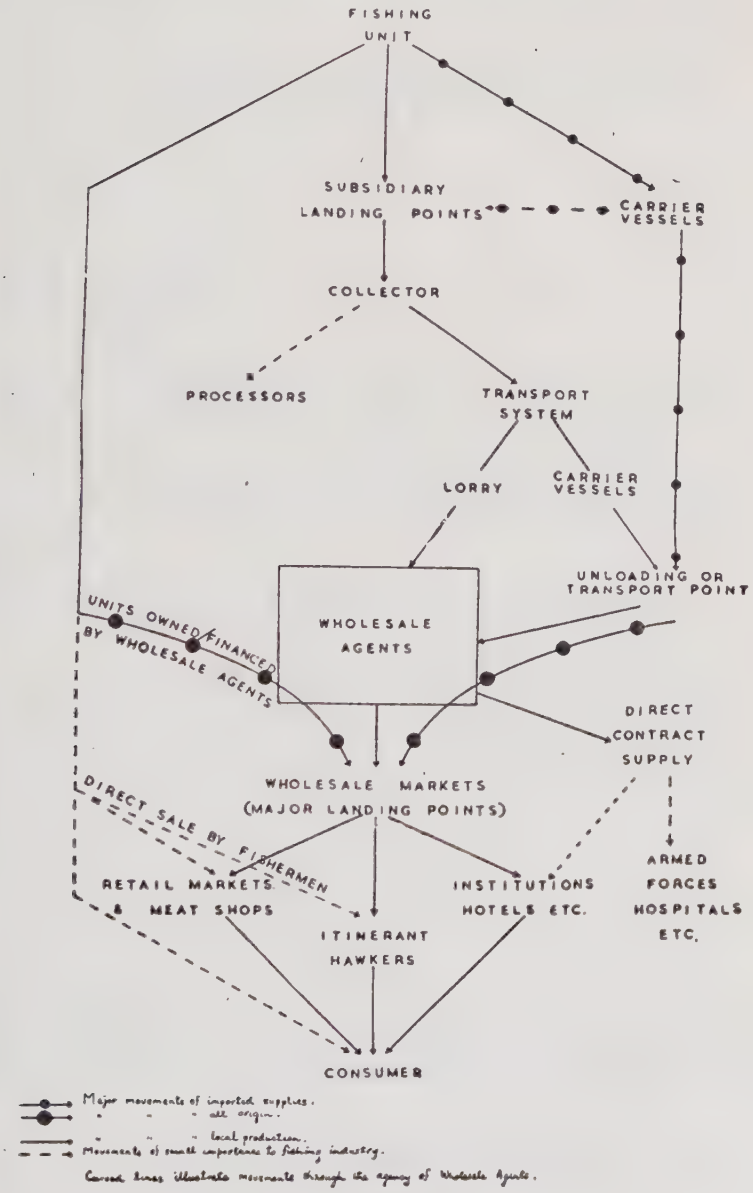


Figure 6

Whilst it is undoubtedly impossible to evaluate a 'man-day of labour' and to distinguish between such days contributed by various individuals, still it is certain that an effort should be made to estimate the total number of effective days contributed by the available manpower. This point will receive further consideration in the section dealing with the operation of the factors of production.

(*b*) *Equipment*—

(i) Craft—Each craft is to be regarded as an instrument by which the catching operations are carried out or are made possible; its effectiveness depends upon its size, seaworthiness, speed and design. To be able to make an overall evaluation of the fleet, therefore, the following information is required in respect of each craft.

(1) Type of Boat.
(2) Date of Construction.
(3) Dimensions.
(4) Tonnage.
(5) Method of Propulsion.
(6) Engine (if any), make, horse-power.
(7) Speed.
(8) Fish Storage Facilities.
(9) Standing Fishing Gear.
(10) Type of Fishing Operation..
  (*a*) Principal.
  (*b*) Subsidiary.
(11) Number of Fishermen Employed.
(12) Ownership of Vessel.

(ii) Fishing Gear—Fishing gear must be considered, on the same basis as craft, as direct instruments of production, and must be classified and recorded in such a way as will permit of an evaluation of productive capacity. This is considered in detail in the second report of this series.

It must be stressed that measurement of the productive capacity of any of these factors of production has been no more than attempted, and the classifications and descriptions presented in this report serve, at this stage, as a means of grouping together those units which may be expected, by virtue of similarities in fundamental properties, to have similar productive capacity.

(*c*) *Finance*—The information required here is the usual schedule of value of equipment together with a record of the means by which the industry is financed and the terms on which capital and operating expenses are available.

B. OPERATION OF THE FACTORS OF PRODUCTION

Under section A, Factors of Production, the survey must make an inventory of the different elements of which the industry is composed, and a classification of them as a means to evaluating their capacity for effecting production. Under the present section the survey must take into consideration the time element. It is clear that no unit of production is maintained constantly in operation and that all units have a definite length of life; it is necessary to record the amount of use which is made of each element in each unit of time and to relate such use to the production which is obtained. There is involved here a question of frequency of use and of the duration of use on each occasion. In the case of gear, the information to be recorded will be clear enough, even if the means of recording may not be simple. In the case of manpower there are various problems: thus, whilst a primary distinction may be made between those who are engaged in professional fishing operations full-time and those thus engaged only part-time, there are nevertheless wide variations in the proportion of each day and each week which is devoted to active operations by different individuals. The collection of information on such points is likely to offer extreme difficulties as the staff employed is insufficient to enable observers to live in the individual villages concerned.

C. VOLUME OF PRODUCTION

This must be recorded in the distinct units by which it appears at various stages in the industry. Thus, the primary unit is the actual catch taken in a single operation of a net or a line or other unit of gear; the next is the total of such catches taken in a single day, or trip; the next is the total within a distinct area or by a distinct section of the industry. Further classification may be made, where necessary on geographic terms, or in respect of units of time, and recognition must be made of the composition of the catch. The latter has importance in relation on the one hand to studies of the natural resources from which the catch is taken and on the other to the studies of the marketing of the catch.

D. COSTS OF PRODUCTION

This, although an extremely difficult section of the programme, is fairly clear in its methodology and follows standard cost-accountancy practices.

E. FACTORS OF DISTRIBUTION

(*a*) *Manpower*—A classification of the manpower engaged in the secondary phase of the industry may be made as follows:—

(1) Collectors.
(2) Carriers.
(3) Process workers*.
(4) Storage plant operatives.
(5) Wholesale agents and staff—clerks, labourers.
(6) Market retail operatives.
(7) Itinerant retail operatives.
(8) Supervisory staff—market employees, etc. Municipal or Government.
(9) Suppliers of producer goods.
(10) Suppliers of capital in form of equipment (financing) or cash (loans).

(*b*) *Equipment*—The equipment of the tertiary phase may be classified as follows:—

(i) Transport:—
(1) Air.
(2) Sea—Vessels (where employed solely for fish transport).
(3) Road—Lorries, cycles, etc.
(4) Rail.

(ii) Storage:—
Fish boxes, ice chests, ice and chilling stores, ice crushing equipment, working platforms.

(iii) Processing:—
Curing yards, stoves, vats, baskets, miscellaneous tools, drying platforms, canning equipment, smokehouse, etc.

(iv) Marketing (Not including storage equipment):—
Markets, slabs or stalls, itinerant stalls, display counters, etc.

(v) Ice making equipment.

(*c*) *Finance*—See above, under A (*c*).

F. OPERATION OF THE FACTORS OF DISTRIBUTION

Similar observations may be made in respect of the operation of the factors of distribution as are made above in relation to the operation of the factors of production.

G. VOLUME OF SUPPLY AND MARKET OPERATIONS

The points of concentration, and the lines of movement of supplies in the Colony's marketing system are illustrated in figure 6 which thus indicates the general organization of statistical collection which must be undertaken. The type of data which can be obtained depends upon the records kept of the movements or transactions; in some cases there is a record of each landing or discharge from vessel or other mode of transport; in other cases the record is of a transaction effected as between the wholesale dealer or commission agent and the purchaser. Since the likelihood of manipulation of figures, or of evasion of obligation to report, is less with the former than with the latter, two sets of data drawn one from the first and the other from the second type of record may not be regarded as directly comparable, and appropriate adjustment must be made.

H. COSTS OF DISTRIBUTION

The remarks above, in relation to costs of production, have a bearing on the problems of this section except that the situation is much more complex; whereas there will be the one set of production costs in respect of any particular lot of fish being sold there may be, in respect of the same lot, several distribution costs, each at different stages in the distribution line.

I. PRICES

The collection of statistics in respect of prices presents considerable problems. Each lot of fish as it progresses through the distribution channels changes hands generally four times and often more and since there are often no actual records of such transactions, and generally, whether there are records or not, the information is not readily made available, the estimates of prices over a full range of transactions for a variety of items must therefore be based upon scanty information.

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*Process workers are included in the tertiary phase of the industry for convenience since the number employed is small and the quantity of fish handled is negligible. In an advanced ndustry they should be treated separately as secondary industry.

2.2 COLLECTION PROGRAMME

Whilst the foregoing section properly lists the full schedule of elements in spect of which statistical data will be accumulated in relation to the industry indicated in figure 6, the actual collection programme must be planned with propriate assignment of priorities.

The collection programme must be designed with a view to gathering atever amount of data may be required of each element, and with an eye the costs of such collection. In particular a distinction must be made in pect of those elements of which complete enumeration is practicable and se for which a sampling programme must be undertaken. The following tes give some explanation of the programme followed and of the difficulties countered.

A. FACTORS OF PRODUCTION

The primary inventory of these factors is prepared chiefly on the basis of nsing statistics, the forms for which are given in Appendix I. Certain items equipment are not subject to licensing and in order to gain some idea of ir numbers an enquiry was made in all villages during 1949. This amounted an attempt at complete enumeration and since, as such, it proved unsatistory, a sampling method will be employed in future*. Moreover, an amendnt to the fisheries legislation has been proposed and is now under considern, which will greatly reduce the errors arising from the exemption from nsing of certain types of gear.

An inventory of fish culture ponds is in progress and some information is eady available from returns made by certain wholesalers who are largely ponsible for marketing the production.

B. OPERATION OF THE FACTORS OF PRODUCTION

In the past there were no records of the operation of these factors. This of rse led to some completely erroneous results, as for instance, the assumption t each man licensed as a fisherman could be counted as contributing a year abour to the industry — and, of course, that all such units were equal. In the vey programme an estimate of these operations is obtained by sampling hods and three officers are engaged in keeping these records although this ot their only duty, since they are field officers responsible for the administion of the fisheries in the areas to which they are posted.

Preliminary results have shown that the fishing stakes or *kelongs*, which are fixed and semi-permanent nature, produce approximately 70 per cent of the l local catches. These units do not, however, fall into clearly defined village s but are found over a greater part of the coast-line of the Colony. It is, efore, desirable to consider this fishing gear separately in respect of the man- n which the sample was determined. Records have been maintained for a small nber of fishing stakes since 1948 but these gears are mainly controlled by perative and generally literate owners or agents. In the first place, therefore, e operatives were requested to include all the *kelongs* maintained by them in returns, it being felt that this did not constitute a serious discrimination as owners are not concerned in the operation of the fishing stakes and the gear nstructed to a more or less uniform pattern. The geographical distribution of e stakes was then considered and further stakes intermediate between these e selected. A request was then made under the provisions of the Fisheries inance and Rules, with the support and assistance from local persons of tion, for returns from owners and/or operators. In the meanwhile no licences were issued nor were stakes re-licensed for the ensuing year, except

*See Appendix II on the use of sampling methods in this work.

subject to the condition that the operator should submit a daily return of fish catches. Clearly this is leading towards total enumeration and a revision of the sample fraction will be made from time to time in accordance with the variability of the sample and the availability of staff for the laborious work of compilation. Since these returns are all obtained through persons employed in the industry, checking is desirable and will be carried out by the officers concerned in due course.

Units other than *kelongs* were selected on a village basis and in the first phase attempts were made to obtain data regarding each type of gear from each village. Selection in the village was made from operatives in the following priority order:—

(i) Literate operatives.
(ii) Operatives prepared to co-operate fully. } Rare.
(iii) Operatives re-licensing or licensing gears, the return being filled in wherever possible by the village headman or local schoolmaster where the operator is illiterate. In spite of using a simple form it has been found impossible to obtain a full return in such cases and extension to include catch composition, particularly in view of its heterogenous nature, is at present impossible.

The selection of operatives was necessary in the first place to obtain immediate information regarding the fishing industry. Clearly this was not random selection but until a fisherman appears for licensing or re-licensing of his gear it is difficult to obtain his co-operation. Random selection followed by making the submission of returns a condition of all new or renewed licences. Licences were issued either from the headquarters office or in the village; in the case of operators employing a comparatively rare gear all were required to submit returns, but where the number of gears concerned was large the field officer concerned selected fishermen who were known to him or who were agreeable to submit such returns. A truly random sample could not be obtained without vigorous enforcement of certain provisions of the Fisheries Ordinance. This would lead to statistics of doubtful value and to a deterioration of the existing friendly relationship existing between members of this department and the fishermen concerned.

Information obtained from the returns is as follows:—

(1) Daily catch.
(2) Number of days operated.
(3) Alternate gears employed and the daily catch of such gears.
(4) Catch composition (in some cases only).
(5) Fishing grounds worked.

This information is used among other things in an estimate of costs of production. The study of the fishing gear of Singapore, to be published as the second report of this series, contains a detailed inventory of the gear with a preliminary estimate of the value of the main types of gear and of their potential productivity on grounds worked at present.

Appendix II gives an account of the use which has been made so far of sampling methods and gives the reasons for believing that, for the present, the methods in use give a sufficiently close estimate of the operation of these factors in the industry. The Appendix also indicates the means by which it is intended to improve this sampling and to reduce its cost.

C. VOLUME OF PRODUCTION

The programme, described above, for the collection of information on the operation of the factors of production accomplishes, at the same time, the collection of information on production.

D. COSTS OF PRODUCTION

The programme in this section is most incomplete. Detailed information on the cost of fishing materials has been systematically collected for some time, but the conversion of this into an estimate of the 'equipment maintenance' item of production cost has not yet been made. There is also some information on the costs of construction of gears, which, with the information on materials, will give estimates of capitalization costs, but these data must be extended before it will be possible to develop their use.

E. FACTORS OF DISTRIBUTION

The programme in connection with this section consists chiefly of a census of equipment.

F. OPERATION OF THE FACTORS OF DISTRIBUTION

There is as yet no programme in connection with this section.

G. VOLUME OF SUPPLY

The statistics of market supplies are obtained at a number of points. The actual handlings of two markets are recorded by market authorities; the auction transactions at three of the markets are recorded and made available by the agents. Importations are recorded by the Department of Statistics and the landings of vessels operating in the Riouw Archipelago are recorded by the Fisheries Department on the basis of a report made by the master of the vessel when applying for his next permit. The quantities supplied to institutes and to the armed forces are reported, on forms provided, by the suppliers concerned.

H. COSTS OF DISTRIBUTION

Record is kept of the charges made for the transportation of fish from various points. Other than this, the data concerning distribution costs are as yet not recorded.

I. PRICES

The returns obtained in respect of fishermen's transactions are recorded in some cases from reports made by fishermen in respect of the actual price per katty which they receive, or in a few cases from reports by village headmen of transactions which are reported to them by the fishermen concerned. Similarly, certain collectors report the price which they receive for the fish they have collected from their circle of fishermen. The prices at actual auction operations are similarly recorded, both as actual transactions (taken by Fisheries Department staff from actual records), and as reports of transactions made observed by agents/market owners and by Municipality staff. Retail prices are recorded in a variety of ways; Food Control Inspectors make a daily report (in respect of two of four markets) of their impression of the price level of retail transactions drawn from their observation of actual transactions taking place in the market. The Municipal staff at the two major markets transmit a daily report made by the retailers of the average price at which each of the principal types of fish have been sold. The Fisheries Department staff working in a wide circle of retail markets (thirty in number) records the ruling prices at which fish is sold. Finally, information is obtained from consumers of the price actually paid to hawkers. This programme presents numerous difficulties and much work has yet to be done to develop this collection of data into an integrated pattern in which each series will make a contribution to the general estimate being attempted and at the same time afford a means of checking.

3. DESCRIPTION OF THE DATA AVAILABLE

THE DATA available may be considered in two sections. Firstly, those which were assembled pre-war and which are available only from published reports, all departmental records having been lost during the occupation. Secondly, those which are available from the post-war programme and which in the main have a continuity, however tenous, with the present detailed survey programme. No information is available as to the methods which were employed pre-war in the collection of data, apart from the fact it was done by the staff of the Municipal markets and was submitted daily. There were five markets involved, namely Clyde Terrace, Ellenborough, Telok Ayer, Orchard Road and Kandang Kerbau and since only the first two were auction markets it is possible that the quantities reported from others had already been accounted in the record for the first two. However, since the quantities in these other markets were only a small fraction of the total supplies (less than 5 per cent) the error would not have been great. Furthermore, these records did not take cognizance of the handlings at private auction points outside the Municipal area, such as Upper Serangoon and Marine Parade. Again, no record was kept in respect of the types of fish landed before 1931 and even after that date the records are to be treated with the greatest of caution. For instance, except for the small record in respect of 1929/31 there is no mention of landings from Bagan Si Api Api (Sumatra) or from Lingga Archipelago, although trade with those areas was important and it might have been expected that there would have been importations of fish from there. Again, it is known that the *moro ami* gear was introduced prior to 1922 and there is reason to believe that the Japanese production in 1927 actually was in the order of 30 per cent of total landings but it is not shown in the records. This would mean that the substantial increase in the landings from Karimoen and Batam from 1924 to 1928 was actually provided by Japanese operations and that the sudden drop in those landings in 1929 was in truth merely a statistical one when, in that year, the Japanese landings were separately recorded. There is no further information available on these records and it must be accepted that much was lacking in the actual technique of collection.

Turning to the post-war data, the available series are listed below*:—

A. FACTORS OF PRODUCTION

(*a*) *Manpower*—Annual enumeration, 1922–1938 and 1947 to date.

For the period 1922 to 1938, only licensed fishermen were included in the published annual enumeration. Fishermen who operated gears not subject to licensing regulations and those who merely assisted licensed fishermen were not included. Moreover, there was no recognition of differences in the number of days on which each fisherman was engaged in actual fishing operations and it is known that both part and full-time fishermen were included in the number. In the post-war period, efforts have been made to include both categories of non-licensed fishermen and evasion of licensing has been reduced by the increased activity of this and other departments. The distinction between part and full-time fishermen has yet to be made.

(*b*) *Equipment*—(i) Craft—Annual enumeration, 1922–1938 and 1947 to date.

With the increased importance placed on the security of this Colony the accuracy of the enumeration of fishing boats has reached a high standard. The accuracy of the pre-war records is unknown but the error is believed to be small.

*See also Appendix III.

(ii) Gear—Annual enumeration 1947 to date.

The enumeration of fishing gears is complicated by the fact that gears operated for the capture of fish for personal consumption, e.g. cast nets and lines with not more than three hooks, are excluded from licensing regulations. Moreover, no provision is made in the legislation for a reduction in the licence fee for fishing gears employed subsidiary to the main method, as a result of which evasion of licensing for subsidiary methods is common. Legislation is now under consideration whereby complete licensing of fishing gears will be possible with the exception of certain minor gears, including cast nets and lines with not more than three hooks, for the enumeration of which sampling methods will be employed.

(iii) Pond Cultural Area,—Census, 1949—

(*a*) Carp ponds—Incomplete Census, 1949;
(*b*) Prawn ponds—Census, 1949;
(*c*) Other Cultural Methods—No data available.

Few data are available regarding the area under pond cultivation and the census in 1949 was implemented, through agents responsible for the marketing of the fish concerned, on the basis of the licensing statistics for the nets and other gear employed. It does not include, therefore, cultivation for personal consumption and its accuracy is probably not of a high order. A new survey is being implemented which is to be based on the aerial survey of the island followed by field enquiries.

(*c*) *Finance*—No accurate information is available regarding the financing of the industry. Something is known of the means whereby the operators obtain finance, but the amount and cost of loans obtained is not available. Although it is known that indebtedness in some form constitutes a serious problem here as elsewhere in the region, measurement of it awaits detailed special study.

B. OPERATION OF THE FACTORS OF PRODUCTION

(*a*) *Sample survey of fishing intensity* —October 1950 to date.

A further discussion of the sample survey of the productivity and usage of fishing gear will be found in Appendix II.

(*b*) *Sample survey of harvesting of cultural ponds*—
(i) Prawn ponds—October 1950 to date;
(ii) Carp ponds—No recent data.

C. VOLUME OF PRODUCTION

(*a*) *Sample survey of productivity of major fishing gears*—4 types 1949 to date (incomplete). 20 types October 1950 to date.

(*b*) *Sample survey of productivity of pond cultivation—Prawn Ponds*—October 1950 to date. *Carp and other culture*—estimate based on pre-war data.

D. COSTS OF PRODUCTION

(*a*) *Cost of Fishing Gear.*

(i) Cost of fishing materials—1948 to date (monthly).

This information was originally obtained from a number of the leading dealers but as variation was small and the staff was not available for compilation it was reduced to a single return from the main wholesale/retail dealer in fishing materials.

(ii) Cost of complete gear—1949 onwards.

Information regarding the cost of materials and labour employed in the construction of fishing gear has been collected from 1949 onwards. From the inventory of the industry and this information, the value of the fishing gear employed in the fisheries of this Colony can be estimated.

(iii) Maintenance and repair—no data.

(*b*) *Cost of Fishing Craft.*

(i) Cost of materials—no data available;

(ii) Cost of completed craft.

Only fragmentary data are available regarding the costs of completed craft and these are obtained from the boat builders' receipts which are produced as proof of ownership by fishermen when applying for licensing of their craft. A procedure similar to that employed in the case of fishing materials is being adopted.

(iii) Maintenance and repair—no data.

(*c*) *Operating Costs.*

Some data are available regarding the cost of licence fees and permits, ice, fuel, salt, provisions and miscellaneous stores. Copies are now retained of all fishing boat manifests in respect of all vessels passing through the recently established fisheries control point. Compilation and detailed study are necessary, however, before a series of value can be developed.

(*d*) *Depreciation.*

Data relating to the depreciation of capital equipment are fragmentary and will be expanded during the course of the survey to provide the information upon which this factor can be evaluated.

E. FACTORS OF DISTRIBUTION

(*a*) *Transport.*

(i) Manpower—no data;

(ii) Equipment—partial census, 1949, Revision, 1951;

(iii) Finance—no data.

Information regarding the number of lorries employed in the fishing industry was obtained in 1948 and is at present being revised. There is no information on other methods of transport (apart from fish carriers for which detailed records are available for 1950 to date), on the manpower employed or on the finance concerned.

(*b*) *Storage.*

(i) Manpower—no data;

(ii) Equipment—partial census, 1949;

(iii) Finance—no data.

A census of cold storage facilities was made in 1949 and is being revised. There is no information on market storage facilities, manpower utilised or finance concerned.

(*c*) *Marketing.*

(i) Manpower—no data;

(ii) Equipment—1951 (incomplete);

(iii) Finance—no data.

Apart from information on the physical properties of the market, data on which are now being compiled, there is no information regarding manpower and finance employed in marketing.

F. OPERATION OF THE FACTORS OF DISTRIBUTION

G. VOLUME OF SUPPLY*

(*a*) *Wholesale Market handlings* by markets (5) (2 since 1936 incomplete. Additional 2 since 1947. 1 since 1-7-50), by types (56) (1-1-50 and 1-7-50), by localities (49) (1947 to date), daily (1947 to date), quantity in katties.

Detailed information regarding the methods of collecting of pre-war data is not always available and their accuracy, therefore, cannot be assessed. The five major markets and auction points have been under observation since 1-7-50 and records have been kept by types since 1-1-50, Post-war data consist of actual handlings declared by wholesale agents to the various authorities concerned, but it is known in the case of the Upper Serangoon Road market that care was not exercised in preparing the declarations. Moreover, in the case of the two Municipal markets evasion of the auction is believed to occur, the fish being disposed directly to regular customers in order to avoid the market levy of 5 per cent of the auction price. Types include related species in most cases and the heterogeneous collection marketed under the term 'mixed fish' is usually re-sorted by the retailer for sale.

(*b*) *Import and Export returns* of fresh fish by localities (on occurrence), monthly, quantity in tons—1937 to date compiled by the Department of Statistics, Singapore.

Import and export returns published by the Department of Statistics, Singapore, are suspect since they are the actual figures declared by the agent concerned and are accepted without physical check, although there are legal provisions for such checking and penalties for false declarations. Furthermore, there is a carry over of imports or exports from one month to another, the month in which the return is compiled being the month in which the declaration is made. Only localities are recognised and there is no distinction by types; in fact prior to 1951, deep frozen fish was included in this head and there is still some confusion between these categories.

(*c*) *Auction Records* for markets (2), by types (as given), for agents (as licensed), daily quantity in katties—1949 to date.

The actual auction records of the Municipal markets are handed to this department for record and compilation after they are inspected by the audit staff of the Municipality. These records should be and are identical with the two Municipal market reports under G. (*a*), but unfortunately the series is incomplete as some of the records have been misplaced in the past.

(*d*) *Total Import from Riouw Residency* by vessels (on occurrence) by types (56), by localities (10)—June 1950 to date.

This return is obtained by the Fisheries Department and is believed to be fairly accurate. Physical check is not at present feasible as unloading occurs at a number of points.

(*e*) *Direct supply* from importers to institutes and the armed forces, by type (as given), daily —January 1950 to date.

Detailed and accurate figures are obtained from contractors with verification from the services or institutes concerned.

There is some internal check between the series relating to the volume and supply, G (*d*) gives a direct comparison with market handlings from Riouw Residency in G (*a*). Similarly G (*c*) consists of the original documents from which part of G (*a*) is derived. Furthermore, local production as estimated in series C can be used for comparison with handlings of local origin in the series

*Figures within brackets relate to the number of individual divisions within each series.

G (*a*) and G (*c*). G (*b*) provides a check against wholesale market handlings of non-local origin in series G (*a*) and imports from Riouw Residency G (*d*). Variation between G (*b*) and the relevant portion of G (*a*) is often marked, partly for the reasons given above regarding its accuracy, but mainly as imported fish provide the major source of contract supplies. When the collection system is improved it will be possible to check the non-local supplies by checking the sum of G (*a*) and (*e*) against G (*b*).

H. COST OF DISTRIBUTION

Gross data available only on costs of transport, ice, etc.

I. PRICES

(*a*) *First Wholesale Price*—by fishing villages (15), by types (as given), as reported by fishermen as to actual receipts or by headman as observed price, daily, cents per katty—October to date.

Prices reported by the fishermen relate to morning transactions which constitute the major portion of the landings. Later landings are paid for at lower rates since storage of the fish until the auction on the next morning is involved. The data of this series are not of very great value since they relate to types of fish which form an extremely small proportion of the market supplies.

(*b*) *Last Wholesale Price*—by areas (9), by types (as given), as reported by collectors as to actual price received, daily, cents per katty—October to date.

This price is equivalent to the auction price less the market levy and the auction agent's commission.

(*c*) *Auction Price*—

(i) by types (20), by markets (5) as reported by agents/market owners (10) and Municipal Market staff (2 Markets only)—1949 and 1950, monthly. November, December 1950, daily.

(ii) by types (as given), by markets (2), from actual auction records daily, cents per katty (see G (*c*)).

Auction prices obtained by (i) are unsatisfactory as there is considerable variation in the size, condition and other physical attributes of the fish concerned. Those obtained from (ii) are actual market records but are received after considerable delay as the records are held in the markets for checking by the Municipal Audit Staff.

(*d*) *Retail Price*—

(i) by types (9 graded into 3 classes), impressions of Food Control Inspectors in two of four markets, from observation of actual transactions; daily, cents per katty—October 1949 to date;

(ii) by types (20), from major markets (2), price reported by retailers to Municipal Staff daily, cents per katty—1947 to date (Monthly) (average);

(iii) by types (20) from markets (30) ruling prices observed by Fisheries Department Staff and/or reported by retailers, daily, cents per katty—October and November 1950 (discontinued);

(iv) by types (as given) from consumer (1) from locality (1) at which fish is offered by or purchased from an itinerant hawker, daily, cents per katty. (This will be expanded when (*a*) standards of price assessment are established; (*b*) the assistance of voluntary workers can be obtained)—1950 to date.

Information regarding retail price is unsatisfactory and this question is discussed further later in this Report.

4. TREATMENT OF DATA

4.1 GENERAL

For the purposes of demonstrating the methods which may be employed in this work, and as the most direct approach to the more urgent problems confronting Government, attention will be directed upon (*a*) the total availability of fish supplies to the Singapore markets, (*b*) the local production of fish and (*c*) the prices at which fish is being sold. In this approach selection will be made of appropriate series of data, some of which will receive exhaustive treatment. Some of the series listed in section 3 will not be dealt with here, either because they are not relevant to the three problems listed above, or because they are as yet too short or insufficiently reliable to warrant treatment; however, the methods described will be applicable to these series in due course and an effort is made in the following pages to show how all series may be brought within the scope of the continuing analytical control described.

The first set of data is to be approached in the present study in much the same manner as a study of data on rainfall: that is to say, the data are to be considered firstly as a simple time series and an attempt is to be made to provide an accurate description of the series in statistical terms without any reference to possible causes. It is presumed that the data will show some secular trend and that the fluctuations about this trend might be systematic in one or more ways. No attempt is to be made to determine any relationship between these availabilities and any other factors or elements; it might not be difficult to propose statistical series which could be correlated with these, but it would be difficult at this juncture to justify such calculations, or to interpret any statistical result which might be adduced. The second stage in dealing with this series is to return to the parts of which the total is composed and to submit each of these to similar treatment. These component parts are of two kinds: firstly, the locality contributions to the total; secondly, the specific composition which, naturally, enters into each locality sub-total as well as into the overall total. It may be expected that interaction between specific and locality components might manifest itself.

The second set of data, that is, that referring to local production, is to be approached initially from the same point of view and with the same methods as is the first. In fact, as one of the locality contributions, these will already have been dealt with to some degree as part of the study of the first series. However, for this series it is practicable to consider the full array of factors which might influence production, as indicated in figure 4, and to contemplate various correlations as a more substantial basis to a prediction system.

Since the fish stocks which are exploited by the local operations are generally continuous with those exploited by the fishing operations from which the importations are drawn and at least are generally subject to similar environment influences, it is extremely likely that results obtained from the treatment of the second set may be applicable to the data of the first set. With due regard for the economic factors it might be possible to effect an extrapolation of some of the correlations of the second set to the first set and thus introduce into the treatment of the first set some of the analytical refinement which is possible in the second set as a result of the more intensified programme of observation and record.

The third series, that is, price analysis, is to be treated by methods similar to those for the second set in respect of correlations and the examination of

time series, but here there will be involved a more difficult task of discrimination and of recognition of levels of significance. Reference has already been made to the practical difficulty of obtaining reliable data in this series.

Reverting to the set of questions posed on page 5 it may be pointed out that the treatment of the first series is expected to yield the answers to the first three questions; that question four will be answered by the treatment of the second series whilst the third series is expected to yield the answer to the sixth question. The answer to question five is likely to involve a greater length of time than these others; the collection of data concerning the finances of the industry, the costs of production and the costs of distribution, is certain to require much more time; furthermore, the analysis of these costs must await the completion of the analysis of the movement of supplies through the different distribution channels.

4.2 EXAMINATION OF TOTAL MARKET SUPPLIES AND OF THE FACTORS INFLUENCING THE MOVEMENT OF SUPPLIES INTO THE CHANNELS OF DISTRIBUTION

Figure 5 gives a representation of the channels through which supplies are drawn and pass for eventual consumption or to waste. Whilst this figure is essentially theoretical in design, and applicable to the fishing industry of any country, an attempt must be made to give each channel a width corresponding to the averagé volume of supplies moving through it for the Colony. However, as will be understood from the account of available information given in this paper, data are as yet inadequate to permit the construction of an accurate diagram and it will be one of the results of the survey that it should make possible the conversion of this diagram into more accurate form. A further point which may be mentioned here in passing is that the diagram might be converted into dietary units, such as calories, or one or more of the proximate constituents of foodstuffs, in order to show more clearly the actual contribution of the industry to the diet of the community.

A point on which it is necessary at this juncture to place much emphasis is the fact that a large part of the Colony's supplies are identified as importations, that is to say, they are taken from waters outside the limits of the Colony, chiefly by fishermen other than those of the Colony.*

As indicated in the diagram, the imported supplies, which include both fresh and processed fish, are supplemented by a proportion of the local production to constitute what may be termed the 'industrial supply' which then passes into the marketing and distributing system. The total availability to the Colony is not yet measured, chiefly because neither the local production as a total, nor the subsistence consumption as a proportion of local production have been reliably assessed. For the lower part of the diagram the indication of the volume of processed supplies is as yet unmeasured although some estimates are available.

In this section we are concerned primarily with the supplies moving in the middle channel, that is 'marketed supplies'. There is probably some interaction between the forces determining the movement into this channel and those which determine movement into other channels, and this possibility must be examined; at this stage, however, our concern is with Channel B alone.

*Imports into Singapore include production by Singapore licensed fishing vessels in waters outside the territorial boundaries of the Colony. This was accepted in the past because the quantity concerned was small but differentiation is being made with effect from 1-1-51.

Turning now to figure 6* in which is given a representation of the organization of the Colony's industry and of the lines along which marketed supplies move to the consumer. The figure suggests that the bulk of the supplies pass through the wholesale markets: in some measure this is at present an assumption since the amount of movement along other lines, notably the sales by fishermen other than through the wholesale markets (figure 6, left hand bottom corner) is not yet covered by the statistical recording system. However, there are good grounds for the belief that the total movement through these unmeasured channels is properly regarded as being small relative to the movement through the other channels.

The data on these supplies are contained in series G (*a* to *e*) † of which G (*a*) and G (*c*) are daily records; G (*a*) being both a wider and longer series serves as the basis for the construction of the compiled record of market handlings. The manner in which the other series are used to supplement and check the data of G (*a*) is described in section 3. The series, then, which will be considered here, is based on a daily record. This has been summed into monthly and annual totals. It perhaps makes no great difference whether these data should be considered first in their annual or other totals, or in the original daily records but it is preferred by the authors to commence with the broader features and to proceed from them to successive types of detail.

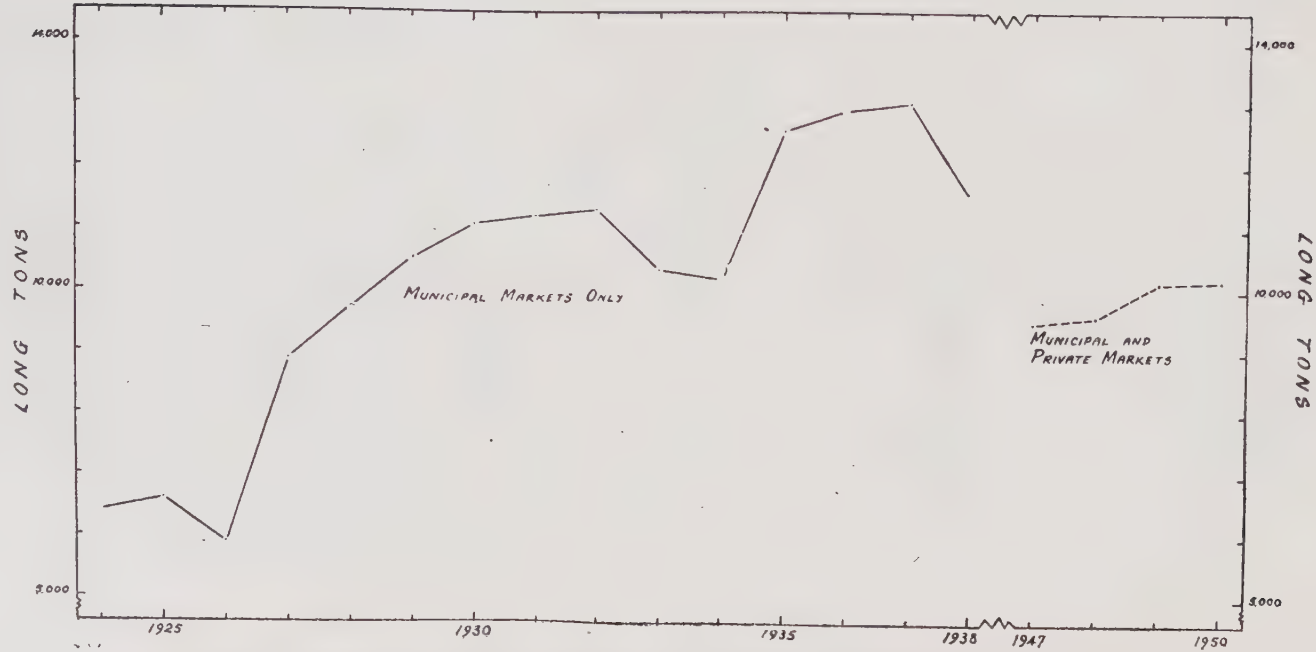
DATA FROM 1924 ONWARDS

The total wet fish auctioned in Singapore markets each year since 1924 is represented in graph 1, which incorporates the data collected pre-war. The most obvious feature of this graph is the substantial growth of supplies from 1926 to 1937 with an important depression in 1933 and 1934; this growth brought the supplies from a level of about 6,000 tons per annum to about 13,000 tons. The significance of the three levels—6,000 tons in the early 'twenties' 13,000 tons in 'mid-thirties' and 10,000 tons in recent years—will appear in subsequent analysis: it is important to attempt to discover the reasons for each of these levels since this may give leads to the type of action which may increase the present levels of supply. However, as indicated in section 3, only certain principal features of the pre-war supplies are known, and it may prove difficult to reach any conclusions in respect of them. On the other hand, it is possible that the detailed analysis of the post-war supplies, more particularly of 1949 onwards, may yield information which will elucidate not only the present, but also the pre-war situation.

Table VII presents, on comparative basis, the figures of fish auctioned in Singapore from various localities over a number of years. These figures show that from 1927 onwards the increase in supply came in the first instance from the Riouw and subsequently from the very considerable quantities brought in by the Japanese. The supply of the early 'twenties' was drawn from Riouw, Johore and local production, and the level of these supplies increased only relatively little up to 1938, the greater part of the increase being provided by the Japanese landings. The Japanese, of course, ceased to operate at the end of the war and since the market had apparently become accustomed to the increased level of supplies, efforts were made to attract fish in greater quantities from existing sources and, in respect of Johore and local production, these

*It is to be emphasized that this diagram relates to the movement of marketed supplies of fresh fish and therefore the supplies for processing (Channel C of figure 5) are indicated as moving to an end-point for the purposes of this figure, and no reference is made to the subsistence consumption (Channel B of figure 5).

†See section 3 pages 30 to 34.



Graph 1. Yearly Total Wet Fish Auctioned in the Wholesale Markets (1924–1938 and 1947–1950)

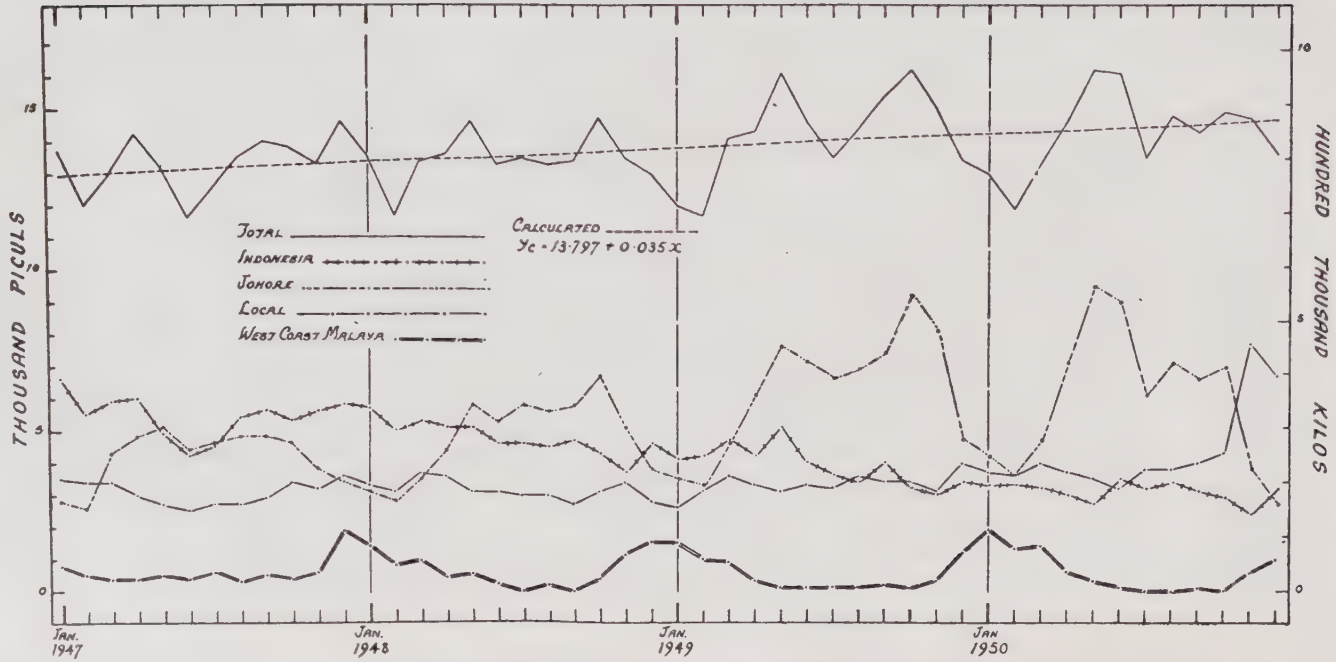
Table VII

YEARLY TOTAL WET FISH AUCTIONED IN SINGAPORE MUNICIPAL AND PRIVATE MARKETS

(Quantities shown as index on local handlings in 1924)

Year	RIOUW AND VICINITY															
	Karimoen Group	Batam Group	Lingga Group	Japanese Landings	Sumatra	Other Indonesian Islands	Fed. of Malaya (West Coast excluding Johore)	Fed. of Malaya (East Coast excluding Johore)	Johore West	Johore East	Johore South (Cucob)	Sarawak	Thailand	Burma	Local	Total
1924	230.8	199.9	..	..	..	..	21.8	..	..	..	37.2	..	..	..	100.0	589.7
1925	213.4	219.3	..	..	..	..	23.9	..	..	..	49.7	..	..	..	101.8	608.1
1926	193.9	246.7	..	..	..	..	12.8	..	..	..	34.1	..	..	..	54.0	541.5
1927	248.0	425.4	..	..	..	..	10.1	..	..	..	39.5	..	..	..	96.7	819.7
1928	258.5	464.9	..	..	..	..	12.1	..	..	..	46.1	..	..	..	116.6	898.2
1929	292.4	128.4	..	393.5	..	..	..	..	..	..	55.1	..	..	..	94.8	964.2
1930	322.7	144.1	..	400.1	..	..	..	..	..	..	47.8	..	..	..	102.4	1,017.1
1931	349.0	98.2	..	416.3	..	..	..	..	..	..	58.7	..	..	..	102.2	1,024.4
1932	322.3	87.3	..	437.4	..	..	..	..	..	..	65.6	..	..	..	122.6	1,035.2
1933	233.0	101.7	..	415.0	..	..	..	..	..	..	80.2	..	..	..	119.0	948.9
1934	232.8	83.6	..	379.8	..	..	..	..	..	..	78.9	..	..	..	160.7	935.8
1935	336.5	111.8	..	508.2	..	..	..	..	..	..	49.3	..	..	..	152.9	1,158.7
1936	330.6	171.5	..	492.4	..	..	..	..	..	..	44.2	..	..	..	143.4	1,182.1
1937	164.9	147.6	..	714.4	..	..	..	..	..	..	43.6	..	..	..	129.5	1,200.0
1938	230.3	152.4	..	490.7	..	..	..	..	..	..	51.3	..	..	..	131.9	1,056.6
1947	67.4	82.8	49.9	..	157.0	..	40.3	..	21.3	88.0	158.7	..	..	..	203.2	868.6
1948	83.2	65.3	62.7	..	89.9	11.8	41.2	..	14.1	114.9	187.5	..	..	..	207.5	878.1
1949	78.3	75.0	42.0	..	51.1	10.7	32.0	..	11.7	157.6	242.4	10.9	..	..	217.9	929.6
1950	60.1	60.8	53.7	..	20.8	8.4	..	..	12.8	211.6	165.7	8.9	..	..	284.9	887.7

The locally produced supplies of 1924 were 1,087 long tons; this has been used as a base in terms of which all other supplies have been referred as percentages. All figures are therefore directly comparable.



Graph 2. Monthly Total Wet Fish Auctioned in Singapore Wholesale Markets

were quite successful. On the other hand the quantities from the Indonesian Archipelago fell steadily so that from a level indicated by the index 382.7 (883.4 if the Japanese landings are included) which was reached in 1938, these supplies have fallen to the level of 200 in 1950 and are still falling.

DATA FROM 1947 ONWARDS

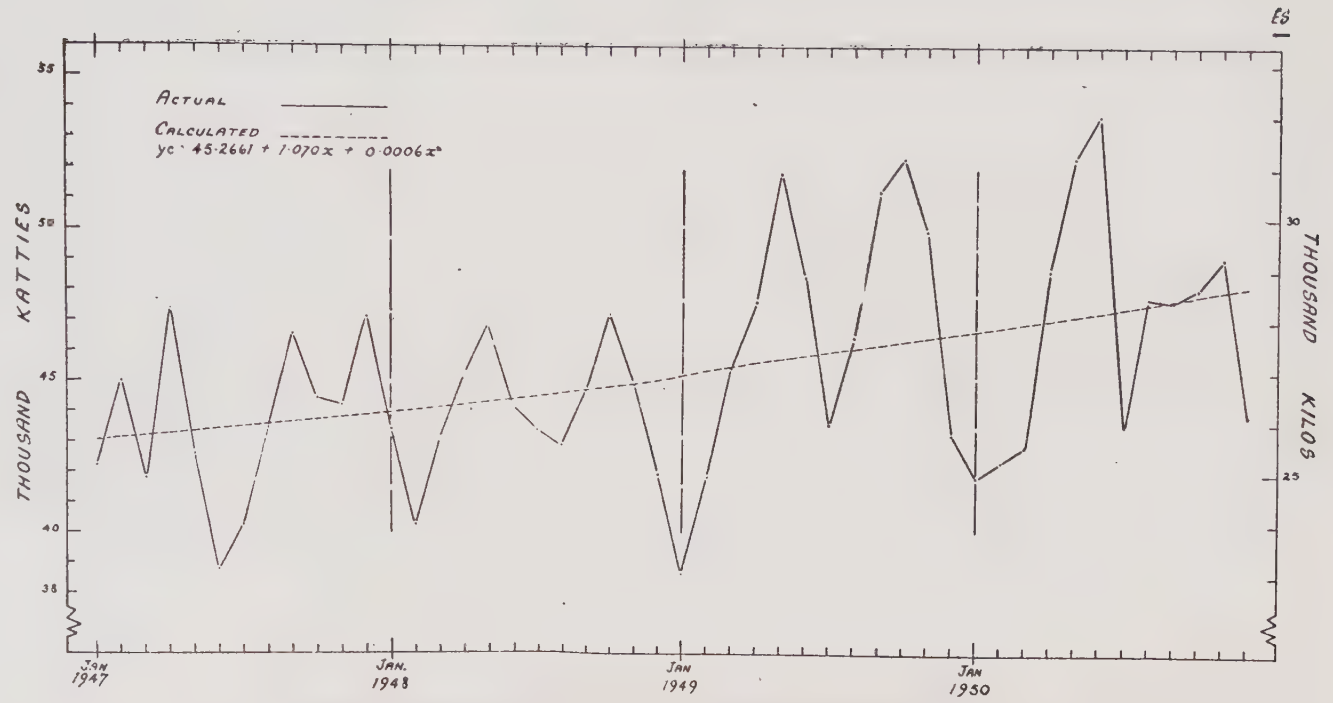
In view of the observations made above concerning the reliability of the pre-war data, it is probably advisable to regard these data as serving simply to indicate the changes which have taken place in the respective roles of the different sources of supply and then to turn to consideration of the post-war figures which already have been analysed in some detail and for which the analysis may be pressed further. In graph 2 the total Singapore market handlings of wet fish for the four years, 1947 to 1950 inclusive, are recorded on a monthly basis. It will be seen that these landings show a distinct upward trend from a level of about 13.4 thousand piculs per month to a level of about 14.2 thousand piculs per month. This graph displays certain regularities in its fluctuations and it might be expected that examination of these would yield useful information. However, the points on this graph represent absolute figures, that is to say, actual quantities landed in each month, and possibly some of the differences between these points (or conversely absence of differences) may be due to the difference in the number of days of each month. Therefore, for the purpose of analysis of these fluctuations, it is necessary to adopt some system of allowing for time difference and the method adopted has been to convert this graph to daily figures averaged in appropriate intervals of time. The first approach to this is shown in graph 3 in which the daily landings are averaged within calendar month intervals. The first result of this conversion is to emphasize both the range of the fluctuations and their periodicity. This is chiefly a graphical effect since the ratio of range to mean of the series is virtually unchanged. However, there are slight changes in the 'shape' of the curve, the total effect of which is to emphasize the two-maximum two-minimum structure of the annual cycle. The display of this feature is of some importance, more particularly against the trend line. Graph 3 emphasizes that a steady increase has been taking place, not only as an increased average, but also with lifting of both minimum and maximum levels. The conversion of data to daily average figures for monthly intervals is required on simple logical grounds and it is considered that the picture which graph 3 presents is likely to be more defensible than the picture of graph 2 for those reasons alone.

It is to be noted that the regression line, as first calculated for the initial three years of record, was straight-line, but during 1950 it became a second degree curve and even stronger changes seem now to be making their appearance.

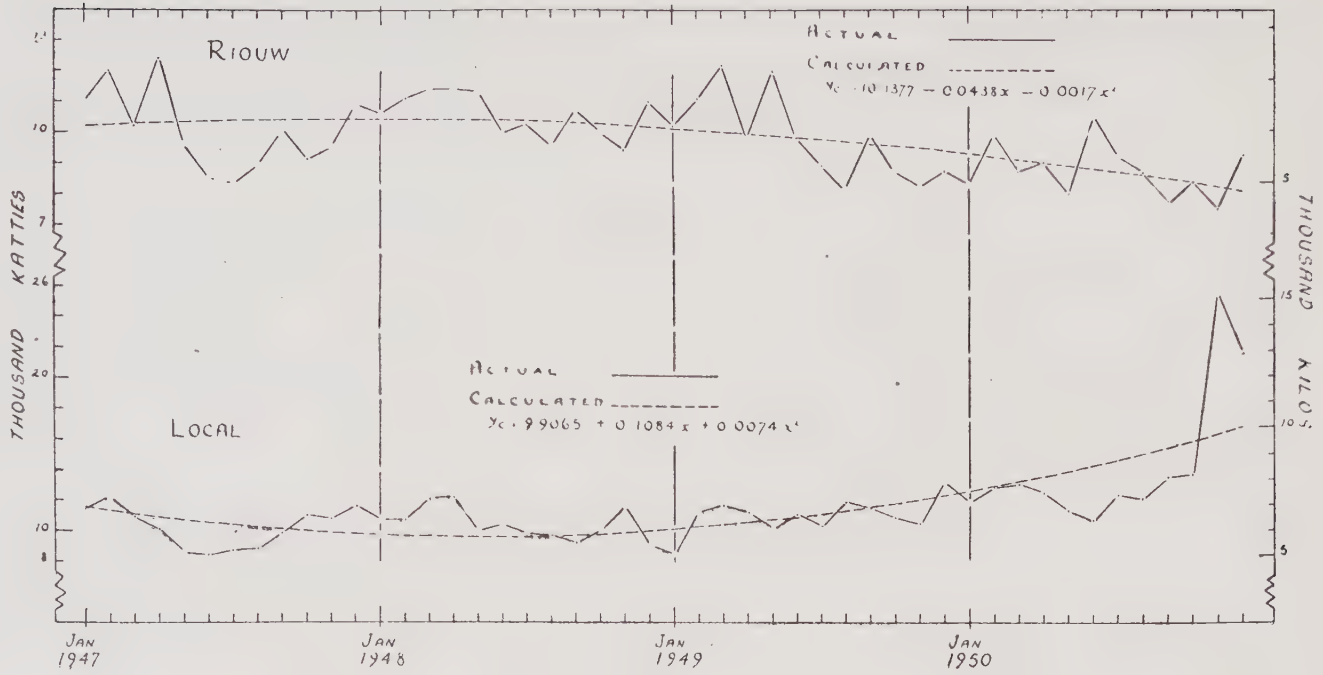
In its present form graph 3 indicates the general trend of the level of supplies and also indicates the annual variation in supply. The next step is to examine the components of these total supplies in order to ascertain whether they all reveal the same pattern of trend and cycle, or whether the picture presented in graph 3 is the resultant of a series of contrary patterns. If the components should conflict in this sense, the intensity of the differences must be measured and it is possible that some guidance to positive action will be found in the results obtained. In the following sections, therefore, an examination of locality and species components is presented.

The current supplies are drawn from localities which may be grouped together in seven sections:—

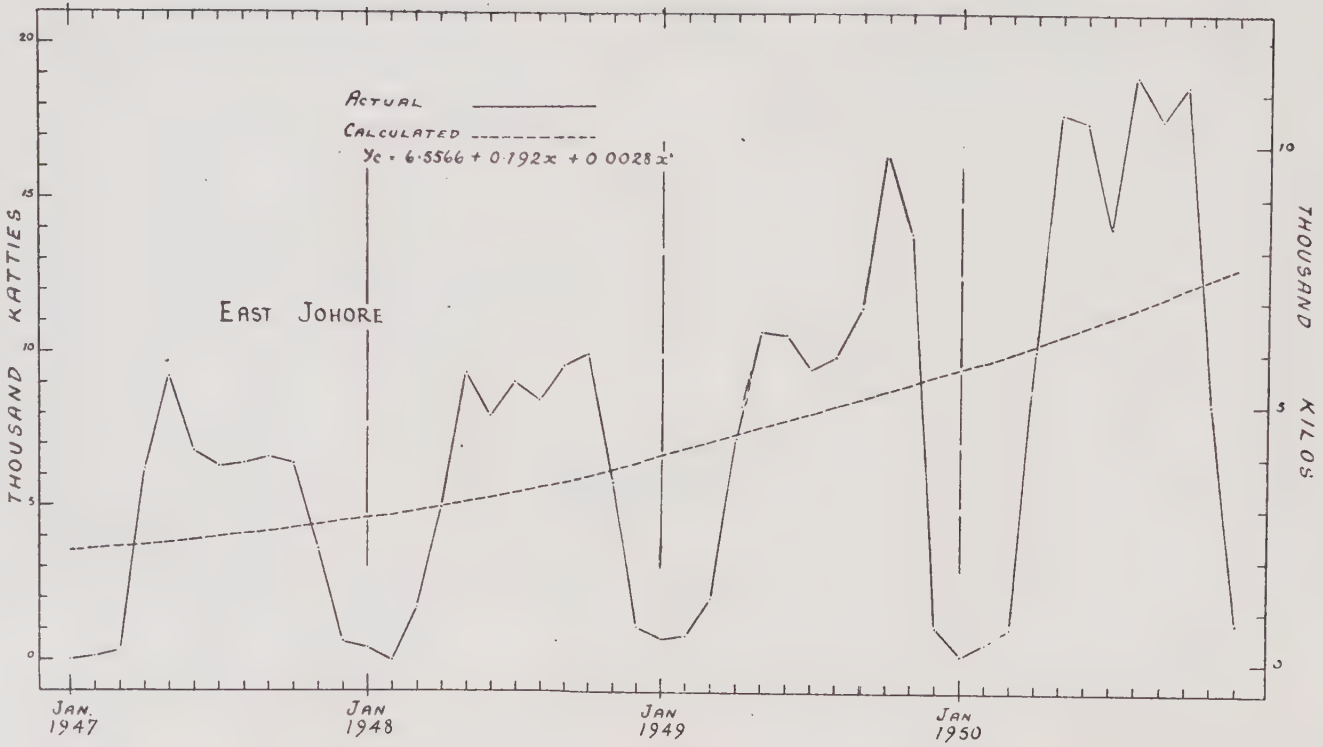
Riouw;
Local;
East coast of Johore;
West coast of Malaya;
South Johore;
Sumatra;
East coast of Malaya.



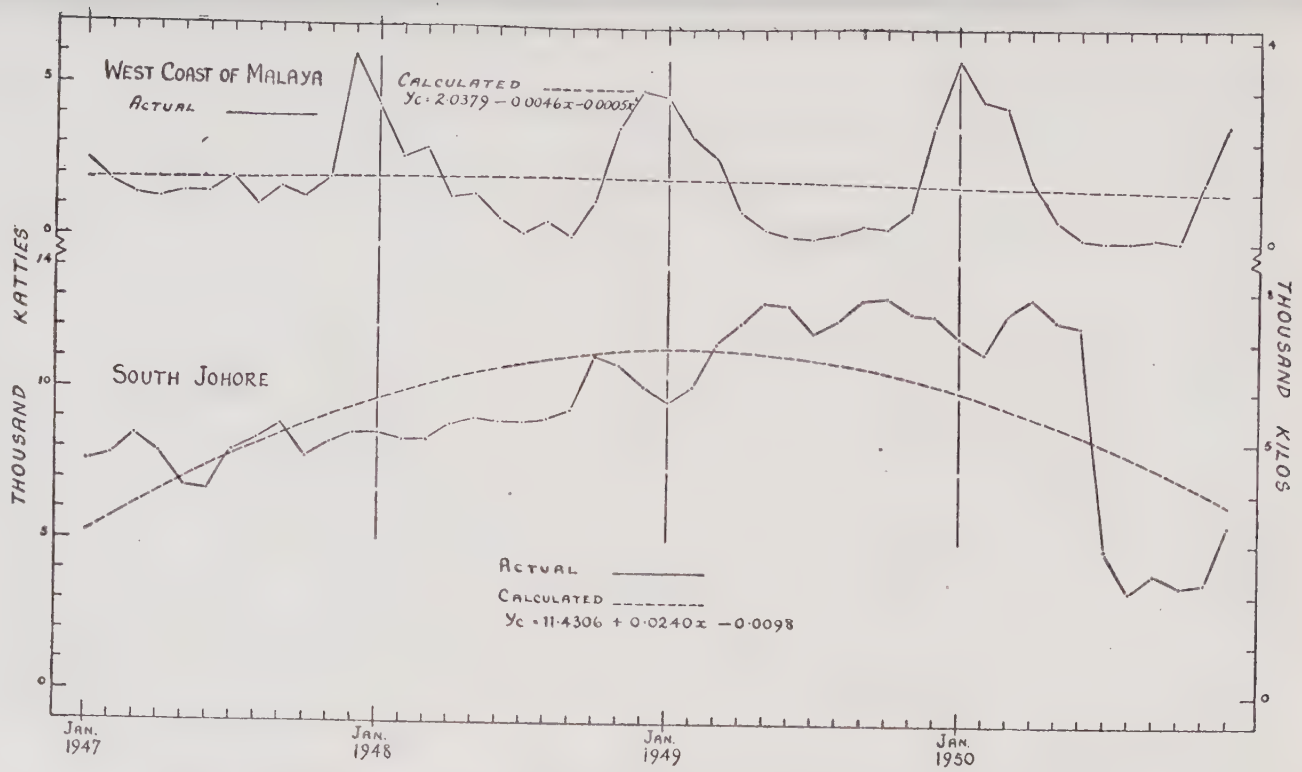
Graph 3. Monthly Average Daily Market Handlings (All Areas of Origin)



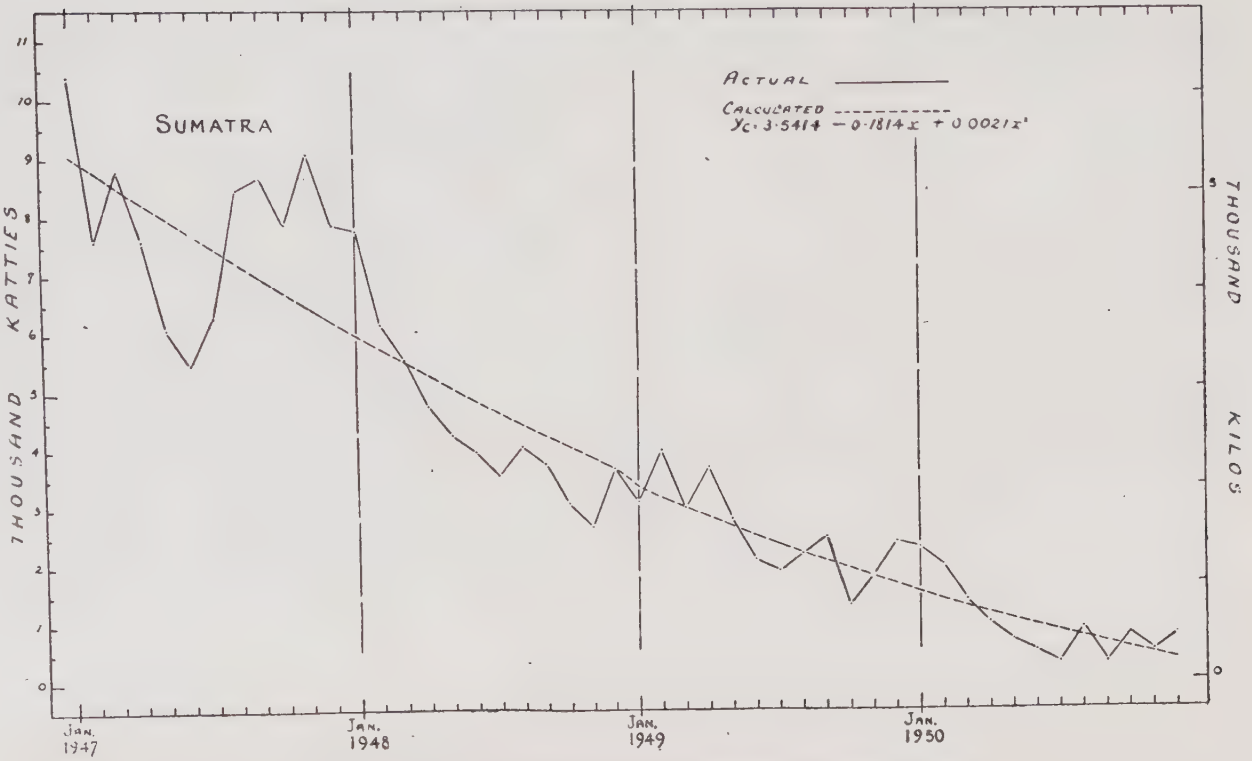
Graph 4. Monthly Average Daily Market Handlings of Riouw and Local Origin



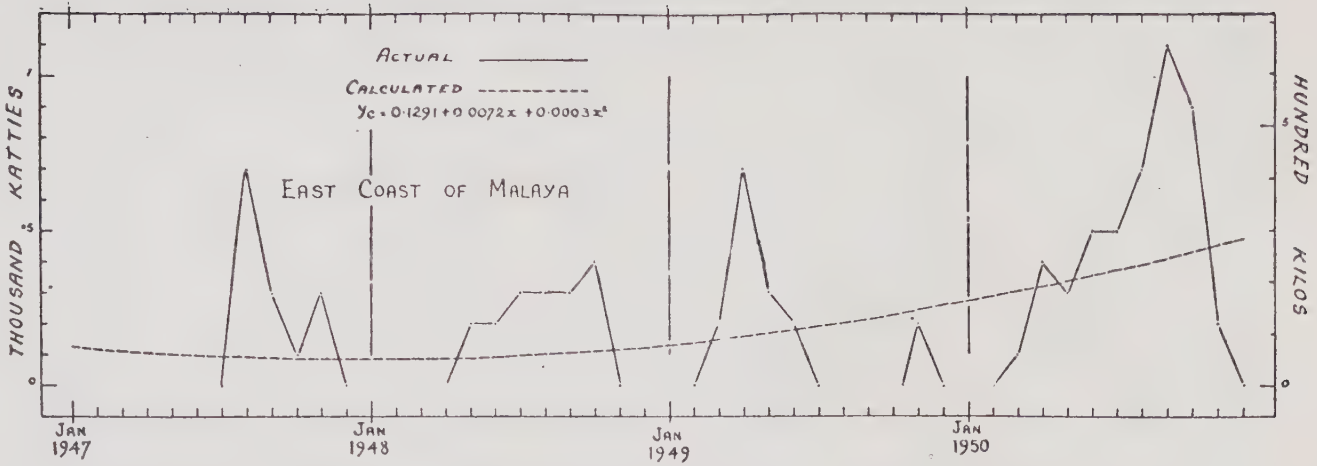
Graph 5. Monthly Average Daily Market Handlings of East Johore Origin



Graph 6. Monthly Average Daily Market Handlings of West Coast Malaya and South Johore Origin



Graph 7. Monthly Average Daily Market Handlings of Sumatran Origin



Graph 8. Monthly Average Daily Market Handlings of East Coast Malaya Origin

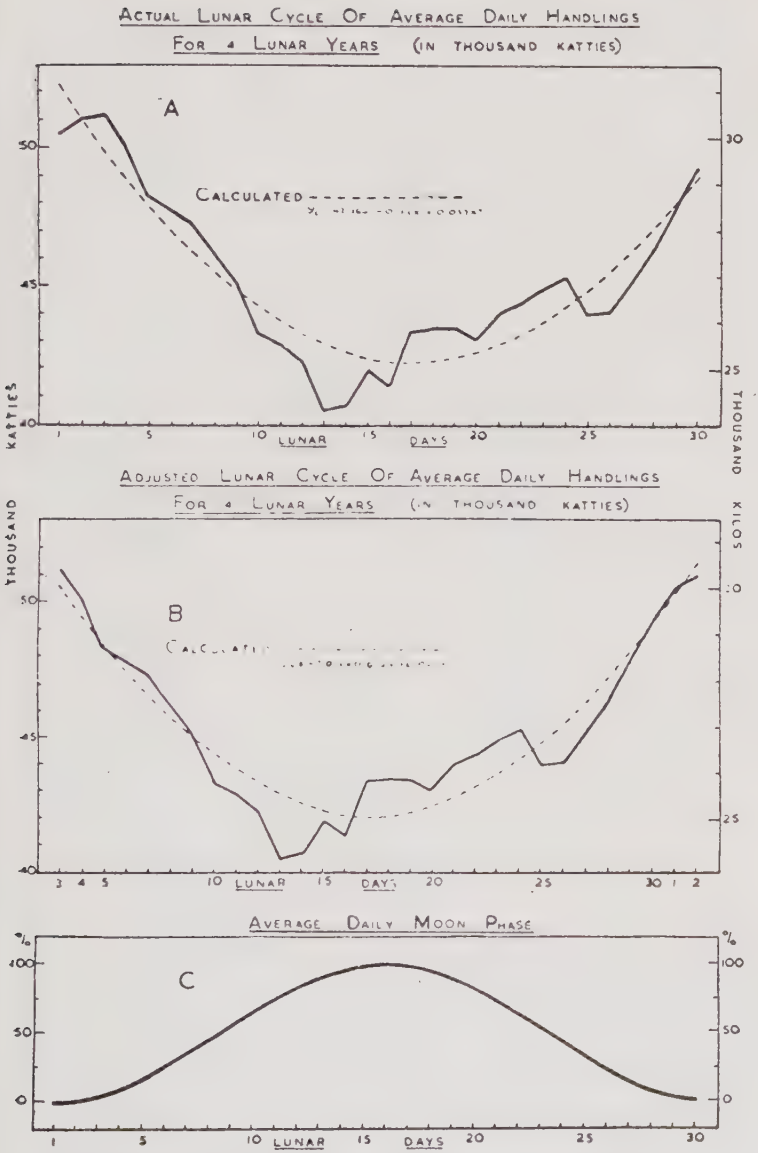
The Riouw and local landings are shown in graph 4 and it will be seen that there is considerable similarity in these graphs but that whilst the local landings have been increasing, the Riouw landings have been decreasing. In point of fact, the local landings increased at a slightly greater rate than the decrease of those from the Riouw and, therefore, the combined supplies from these two localities are actually increasing slightly. The East Johore handlings, shown in graph 5, give a most interesting example of seasonal effect with virtually no supplies in the period December to March and substantial supplies during the remainder of the year. In graph 6 the handlings from West coast of Malaya and South Johore are shown and, with the exception of the last six months of 1950, there has been a steady increase in the supplies from South Johore, and a slight decrease in those from the West coast of Malaya. The Sumatra handlings, shown in graph 7, have suffered a drastic decline. The East coast handlings (graph 8) display irregularity and a marked tendency to increase during 1950. This was not due to increased imports but to the activities of a *moro-ami* unit licensed in this Colony which operated in the islands off the coast of Trengganu during August to October of that year.

To this point, with the exception of graph 2, the analysis has referred to the calculation of average figures from monthly totals, the totals being for calendar month periods; there are, however, reasons for suspecting that calendar month periods might be out of rhythm with the phenomena with which the fishing operations are related. For these reasons the averages have been recalculated on totals for lunar month intervals* and graph 9A presents the overall average for each of the thirty days of the lunar month for the four years of record. The base of the graph is marked off in daily intervals and each point on the line represents the average of about 48 figures; that is to say, in the period of record there were 48 first days of the month and, therefore, 48 handlings to be averaged; and so on for each day of the month. It will be seen that the graph is fairly regular and that the calculated curve fits very well to the original data. In graph 10 the average is represented for each moon of the year separately and whilst in general there is the same phenomenon of a minimum towards the centre of the lunar period with maximum at each end, there is variation as between the different months.

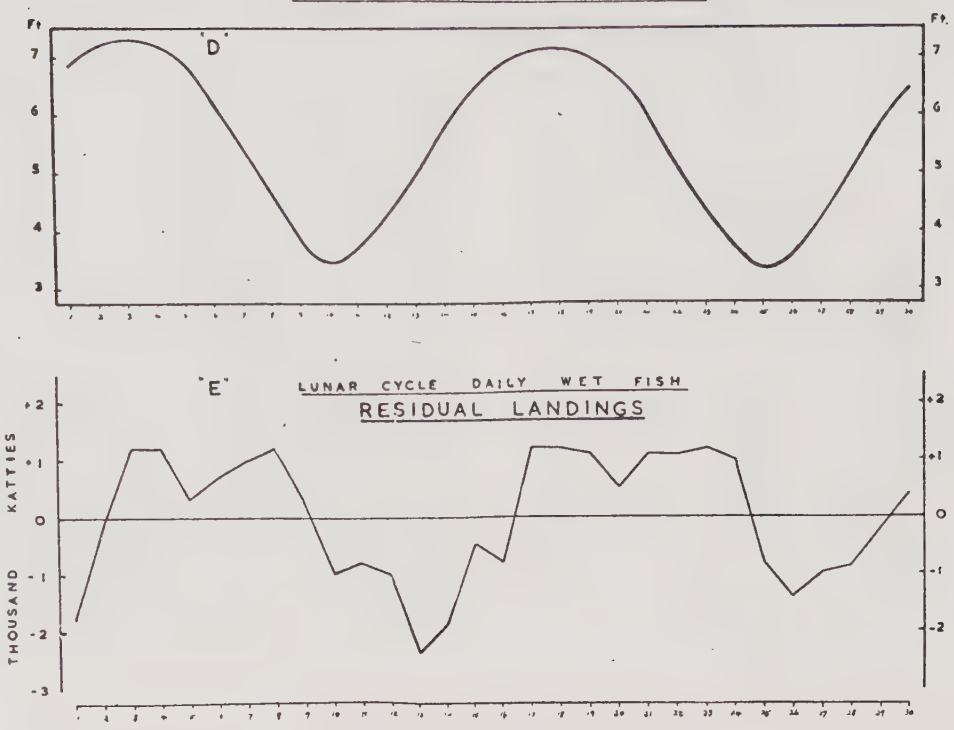
The causes of lunar periodicity in these landings have yet to be determined but there are good grounds for believing that the principal effect is the intensity of light from the moon during the hours of fishing operations. Graphs 9A, B and C show that the landings during the lunar period have a rhythm roughly inverse to the rhythm of the lunar phases, the latter being a symmetrical unimodal curve whilst the former is a catenary with centre of gravity roughly at the same point as the centre of the lunar rhythm; the congruity is best for the curve of graph 9B for which an adjustment of two days had been made to allow for the transport lag between capture of fish and the delivery at the market.

In addition to the symmetry of the calculated curve for landings and its congruity with the lunar rhythm, the deviations of the original curve from the calculated show some regularity which is made apparent when separately plotted as in graph 9E, and it will be seen that the residuals as plotted in this graph have some relationship with daily tidal variation within the lunar period shown in graph 9D. The residuals show a slight lag as against the tidal curve and there is a flattening of both of the maxima. Whilst it is early yet to say whether this flattening has any special significance the following hypothesis may be advanced in explanation of it. The tidal variation, which is plotted in graph 9D, is the mean of the differences between the two flood and ebb tides of each diurnal interval and it is thought that this mean difference may be taken

*The lunar month interval selected is the Chinese lunar month, the first day of which is fifteen days before the full moon (See glossary on page 97).



Graph 9. Mensal Lunar Cycle of Average Daily Handlings with Associated Phenomena



Graph 9—*continued*

to be an index of the intensity of flow of the tide in each interval. It might have been considered preferable to measure actual tide-run, but this varies so considerably according to local physiography that the calculation of a reliable mean value presents what would be insuperable difficulties for this programme; on the other hand the amount of change in water level indicates the rate at which the water must flow. Now while it is known that most of the gears in use depend on current for successful operation, it is also known that certain of the gears in use in the area cannot be operated in water flowing at rates beyond certain levels, generally known to fishermen. Thus, the lift-net of the *kelong* cannot be operated in tidal streams beyond certain strength. Again, the greater the tidal variation the shorter the period of slack water, and since certain gears, e.g. the *moro-ami*, can be operated only in the near slack water, the possible fishing time varies inversely with the tidal difference. On this evidence it is thought that while catches should be positively correlated with tidal difference (as index of intensity of tidal stream), beyond a certain level of tidal difference the intensity of tidal stream must become such as to render some gears inoperable, or at least to reduce their efficiency, and that in addition the fishing time of others becomes substantially reduced so as, perhaps, to make it unprofitable for the fishermen even to wet their gear.

In so far as the imported supplies are brought to the market with a lag between the actual time of capture and the time of record in the market, it is possible that in respect of these there may be an element of error. Moreover, it may be difficult to press the analysis further in respect of these imported supplies. Therefore special attention must be paid to the local supplies. The average daily local landings calculated on the basis of lunar intervals are shown in graph 22 and these will be discussed further in connection with the more detailed study of local production.

The average daily total handlings based on lunar intervals for each month of the period of record are presented in graph 11. This figure resembles graph 3 but there are notable differences such, for instance, as the intercalary peaks in the depressions of mid 1948 and at the end of 1949 and the greater second degree coefficient. However, this graph also indicates the double minimum seasonal picture indicated in the graph based on solar intervals. This seasonal picture is presented as an average in graph 12, and shows a peak in the 3rd and 4th months and in the 8th month and minima in the 6th and 12th months.

From the foregoing it may now be said that the available statistics of the market supplies of Singapore present the following principal features:—

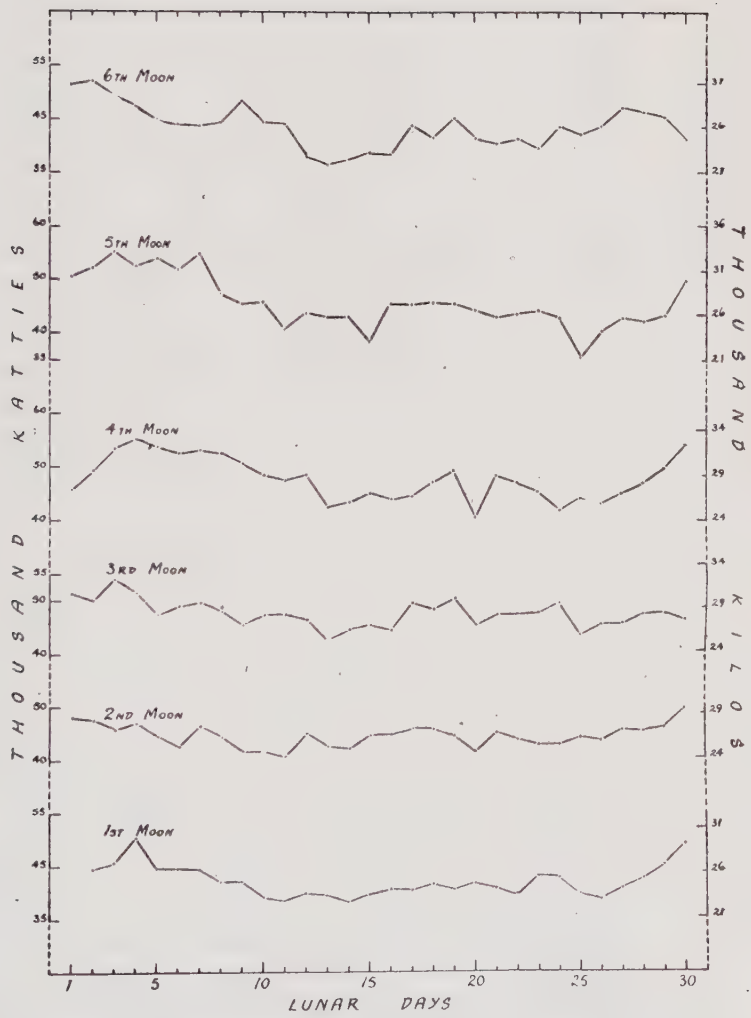
(1) A predominant secular trend with a steady increase in supplies above the level of immediate post-war years and tending to bring these supplies to the peak levels which were reached pre-war chiefly as a result of the Japanese landings.

(2) A seasonal fluctuation with two distinct peaks and two distinct minima which are possibly associated with meteorological features.

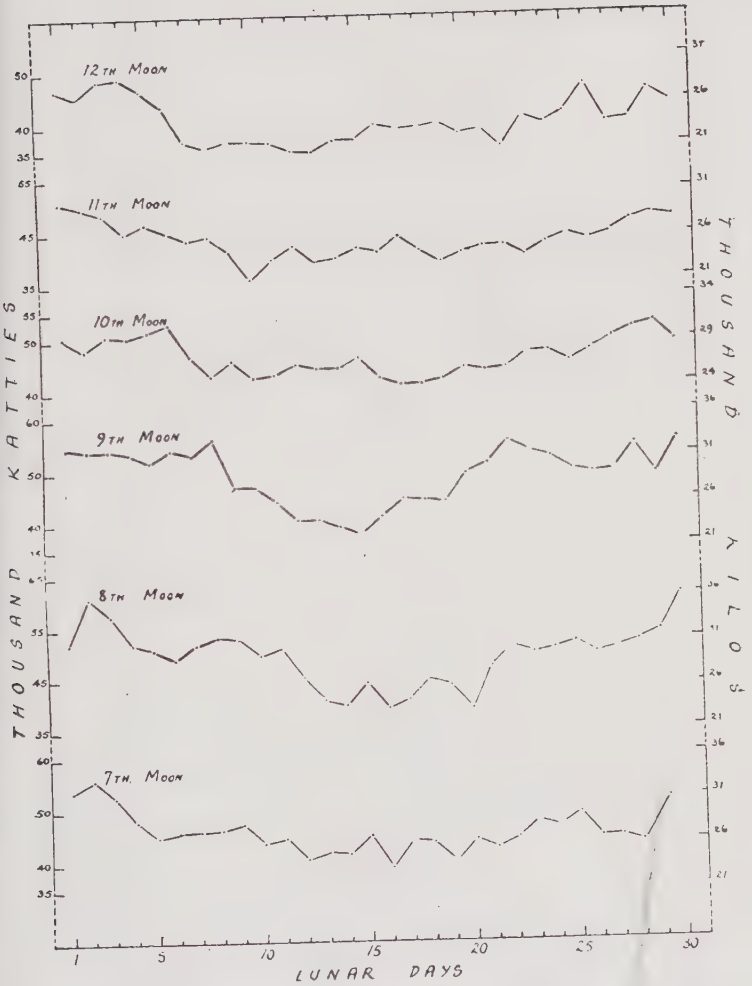
(3) A lunar periodicity with a distinct minimum corresponding in time with the full moon.

(4) A tidal effect by which, within certain limits, the catch is directly related with the mean difference between the diurnal tide range.

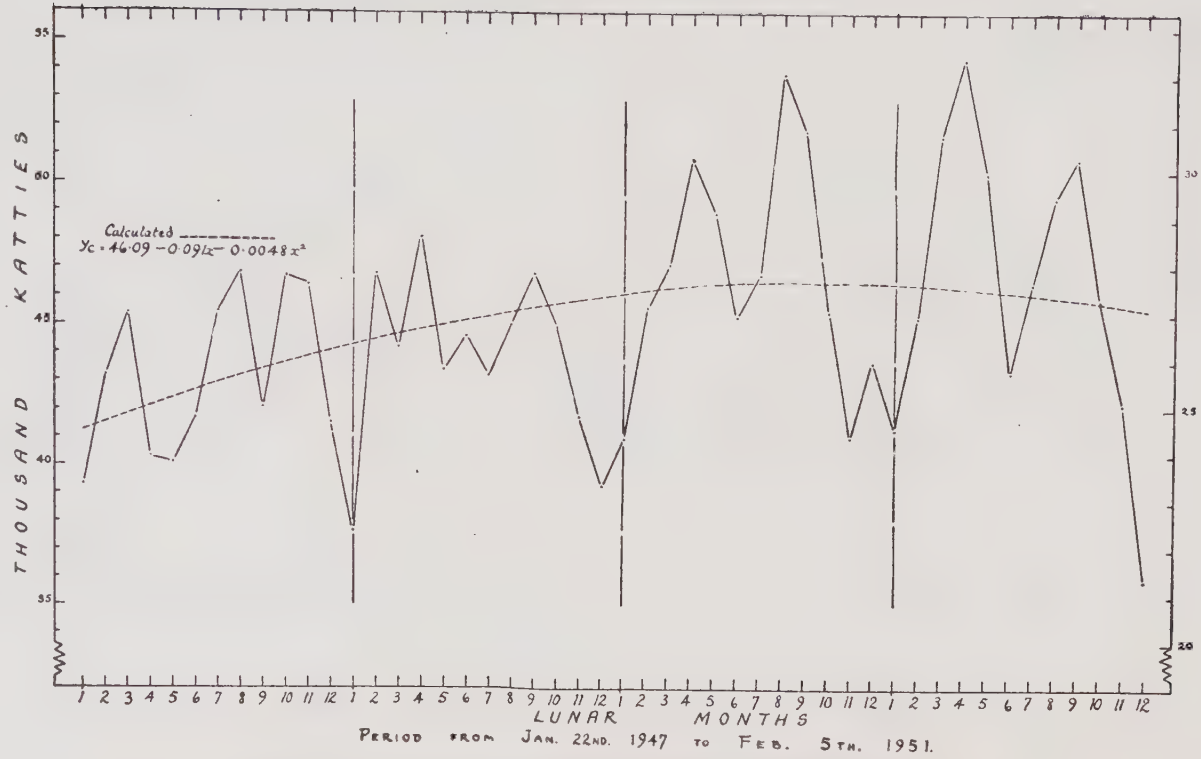
On general grounds these features were to be expected. Thus, the secular trend is characteristic of any industry responding to the demand of a growing population and to sets of factors operating over a number of years. No system such as this shows completely random oscillations. The direction and gradient of the trend is in effect the main historical feature of the industry. However, within each year the efforts of the fishermen are likely to vary in response to a number of factors, notably the major climatic cycles; in addition, the general



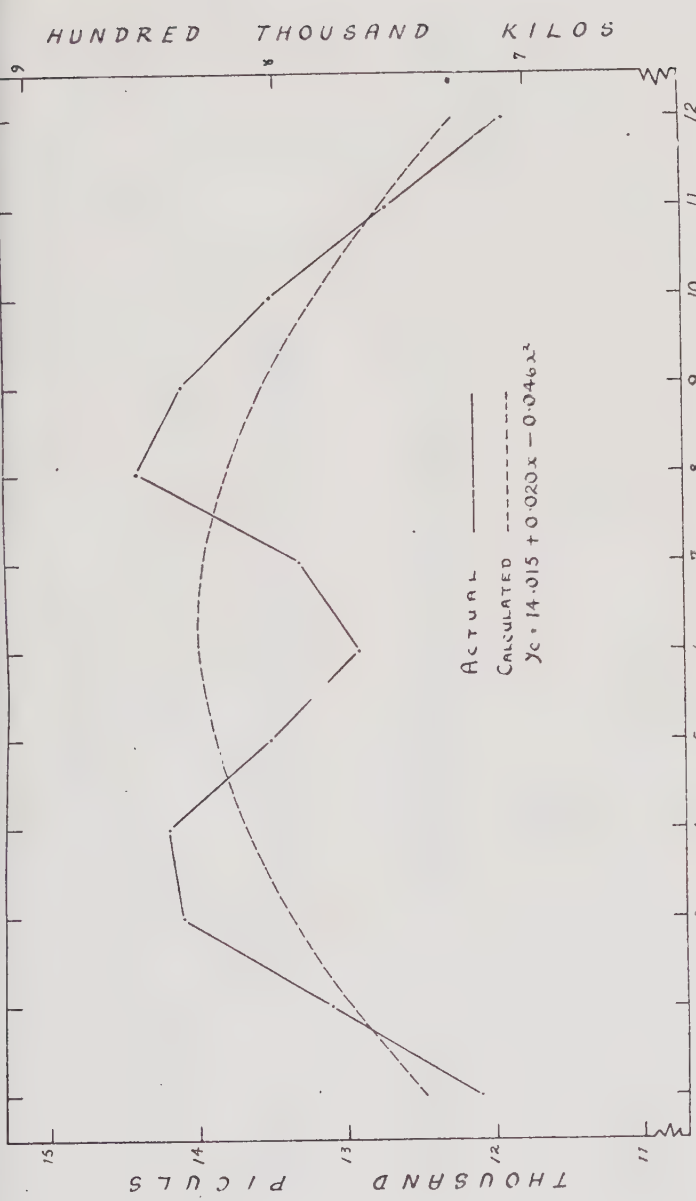
Graph 10A. Lunar Mensal Average Daily Market Handlings. 1st to 6th Chinese Lunar Months



Graph 10B. Lunar Mensal Average Daily Market Handlings. 7th to 12th Chinese Lunar Months



Graph 11. Lunar Monthly Average Daily Handlings Showing Lunar Variation



Graph 12. Average Lunar Monthly Total Handlings for 4 Lunar Years

Table VIII

MONTHLY ERRATIC VARIATION IN WET FISH HANDLINGS,

22-1-47 to 5-2-51

(Weight in thousand katties)

Lunar month	MONTHLY AVERAGE DAILY HANDLINGS		Variation	Per cent variation on observed data
	Observed	Calculated		
1	39.3	37.5	1.8	4.6
2	43.2	40.8	2.4	5.6
3	45.4	44.3	1.1	2.4
4	40.3	44.9	−4.6	−11.4
5	40.1	43.0	−2.9	−7.2
6	41.7	41.4	0.3	0.7
7	45.5	42.9	2.6	5.7
8	46.9	46.7	0.2	0.4
9	42.1	46.0	−3.9	−9.3
10	46.8	44.3	2.5	5.3
11	46.5	41.9	4.6	9.9
12	41.6	39.5	2.1	5.0
1	37.7	40.3	−2.6	−6.9
2	46.9	43.8	3.1	6.6
3	44.3	47.4	−3.1	−7.0
4	48.2	47.9	0.3	0.6
5	43.5	45.7	−2.2	−5.1
6	44.7	43.9	0.8	1.8
7	43.3	45.4	−2.1	−4.8
8	45.1	49.3	−4.2	−9.3
9	46.9	48.4	−1.5	−3.2
10	45.0	46.5	−1.5	−3.3
11	41.8	43.8	−2.0	−4.8
12	39.3	41.2	−1.9	−4.8
1	41.0	42.0	−1.0	−2.4
2	45.7	45.6	0.1	0.2
3	47.2	49.1	−1.9	−4.0
4	50.9	49.5	1.4	2.8
5	49.0	47.1	1.9	3.9
6	45.3	45.1	0.2	0.4
7	46.8	46.5	0.3	0.6
8	53.9	50.4	3.5	6.4
9	51.9	49.3	2.6	5.0
10	45.5	47.2	−1.7	−3.7
11	41.0	44.4	−3.4	−8.3
12	43.7	41.6	2.1	4.8
1	41.3	42.3	−1.0	−2.4
2	45.3	45.7	−0.4	−0.9
3	51.7	49.2	2.5	4.8
4	54.4	49.5	4.9	9.0
5	50.4	46.9	3.5	6.9
6	43.3	44.8	−1.5	−3.5
7	46.5	46.1	0.4	0.9
8	49.5	49.8	−0.3	−0.6
9	50.9	48.6	2.3	4.5
10	45.9	46.5	−0.6	−1.3
11	42.2	43.6	−1.4	−3.3
12	35.9	40.7	−4.8	−13.4

vel of abundance of each type of fish may pass through a cyclical change presenting the sum result of the interaction of the forces of population increase and decrease among the stocks which have a relationship, generally, th the seasonal cycle; moreover, the fishermen undoubtedly adjust their operaons to their experience, or their expectation of the availability of the fish. s a result of these, the fish catches display a cyclical character, related principally the dominant seasonal cycles of the region. Finally, in similar ways the vailability of the fish and the efficiency and intensity of the fishing operations, re related within each lunar period to hydrological and other cycles. The alidity of this argument is indicated, for the average lunar monthly handlings, n Table VIII, where values are calculated on the basis of the regression of nonthly averages (as shown in graph 11), adjusted for seasonal cycle indices rom graph 12); it will be seen that the differences between recorded and calulated handlings are not great and average only about 5 per cent of the recorded gures. These residual differences reveal no periodicity and it may be taken at his stage that the secular trend and the seasonal cycle offer an adequate basis or estimation of total monthly handlings with the set of conditions prevailing when these data were collected.

DAILY PREDICTION

The foregoing technique may be applied to the daily handlings by adjusting he calculated monthly figures on the basis of the lunar cycle (graph 9A). This as been calculated for the period 29th January, 1949, to 16th February, 1950, nd the data thus obtained show a slightly greater difference from the observed handlings than is the case in respect of the monthly variation. Nevertheless, the fluctuation is less than ± 5 per cent on 250 days of the 382 days concerned and a variation of ± 10 per cent includes 353 of the observations.

The importance of the average daily tidal variation in a study of the landings has been previously mentioned. Difficulties arise in a consideration of this factor because supplies are received from a number of areas, and correction for the lag in marketing and for the age of the tide at the point of capture cannot as yet be made. Nevertheless, a significant inverse relationship has been established between the difference of the calculated and observed daily landings for 1949 and the daily tidal fluctuation. The examination of this effect will be continued and in due course will be incorporated in the prediction method in order to isolate the erratic daily fluctuation for further study. This would suggest that refinement of this methodology will provide the mechanism for accurate prediction of handlings subject to reservations regarding the length of the period of prediction and the fact that the series from which the predictions are made is relatively short.

SPECIES COMPOSITION

The supply of fish to the Singapore markets is determined primarily by the availability of fish to the fishing operations and secondarily by the economic and other factors which determine the movement of landed supplies to the Singapore market. Of the primary determinants, the specific composition of the stocks of fish in this region is, of course, of overwhelming importance and in general the handlings of fish are rather heterogeneous and over the year comprise a great many different species. The supplies in fact are divisible into forty-seven major different types plus a category of mixed fish which constitutes 20 to 25 per cent of the total handlings. The latter includes a great many different species which are not represented in the forty-seven main types. However, practically 90 per cent of the catch is made up of twenty principal species together with the group called 'mixed fish' and a group of small fish utilised principally for pig and poultry feeding or as manure. The percentage catch of these species is shown in Table IX in which a comparison is made

Table IX

COMPOSITION OF MUNICIPAL MARKET HANDLINGS BY TYPE (1938 AND 1950)

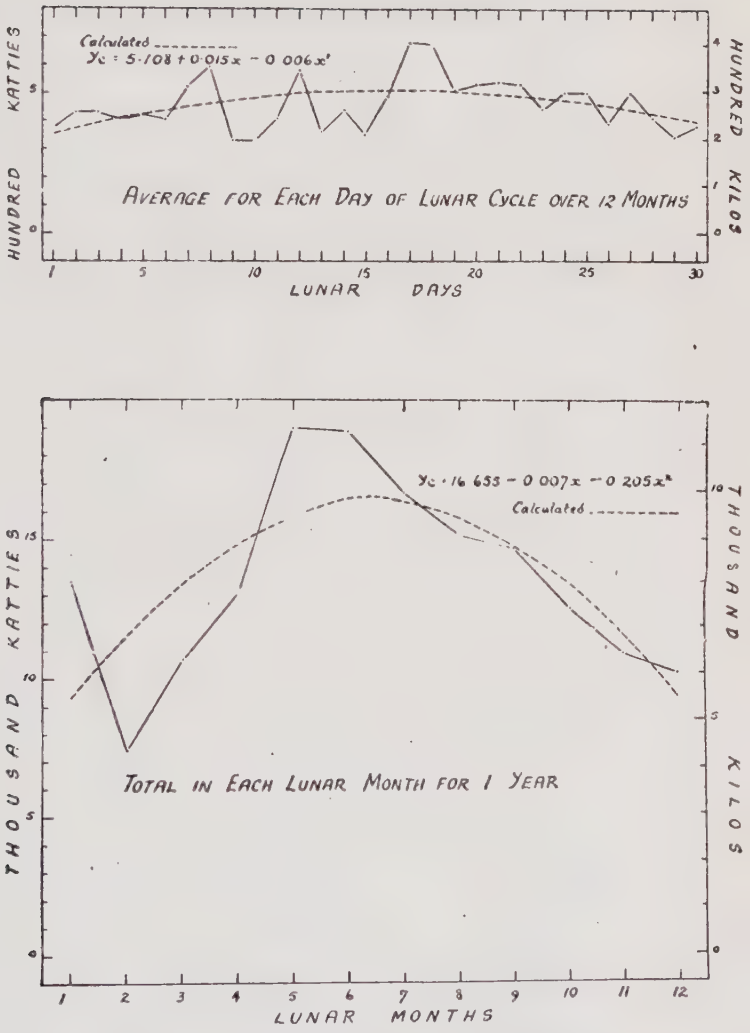
Name of Fish	1938		1950
	Per cent of Total Handlings	Per cent of Handlings excluding Delah	Per cent of Total Handlings
Chencharu (*Megalaspis cordyla*, Linn.)	..	..	1.5
Daing Blang (*Caranx* sp.)	2.7	3.5	0.2
Deham (*Teuthis* sp.)	..	..	1.8
Delah (*Caesio* sp.)	24.6	..	2.8
Ikan Champor (Mixed Fish)	23.2	30.7	23.4
Kekek (*Leiognathus* sp.)	..	..	2.4
Kembong (*Rastrelliger* sp.)	..	..	7.2
Kerapu (*Serranus* sp.)	1.3	1.7	0.4
Kurau (*Polynemus* sp.)	..	..	2.2
Merah (*Lutianus* sp.)	1.7	2.3	1.2
Parang (*Chirocentrus dorab*, Forst.)	8.9	11.8	4.9
Pari—Rays	..	..	1.6
Selar (*Caranx* sp.)	1.2	1.6	1.7
Selar Kuning (*Caranx leptolepis*, Val.)	..	..	6.0
Sotong—Cuttlefish	1.4	1.8	3.5
Tamban (*Harengula* sp.)	..	..	6.3
Tenggiri (*Scomberomorus commersonii*, Lacep.) ..	9.1	12.0	3.5
Terubok (*Hilsa* sp.)	3.1	4.2	1.8
Tongkol—Tunnies	1.6	2.1	2.6
Udang—Prawns	10.0	13.3	6.0
Yu—Sharks	2.6	3.4	2.9
Manure Fish	..	..	3.0
Per cent of Supplies included	91.4	88.4	86.9

between the handlings of 1938 and those of 1950. The first column gives the percentage which each species was of the total handlings and includes *ikan delah*. However, this fish was caught in bulk in 1938 only by the *moro-ami* gear, a method which was introduced and operated practically entirely by the Japanese before the war and which is now worked on a very restricted basis. In order to make a more exact comparison with the 1950 handlings it is, therefore, proper to exclude the *delah* handlings from the 1938 figures and recalculate the percentages and it will be seen that on this base the twenty listed species constituted 88.4 per cent of 1938 handlings and 88.6 per cent of the 1950 handlings. However, there are substantial differences in the relative importance of different species. In 1950 apart from the mixed fish category, other species were represented in fairly similar proportions whereas in 1938 *parang*, *tenggiri* and *udang* were represented by proportions approximately 12 per cent each whilst no other species exceeded 5 per cent. Whether these differences in the composition of the market handlings are of any great significance has yet to be considered.

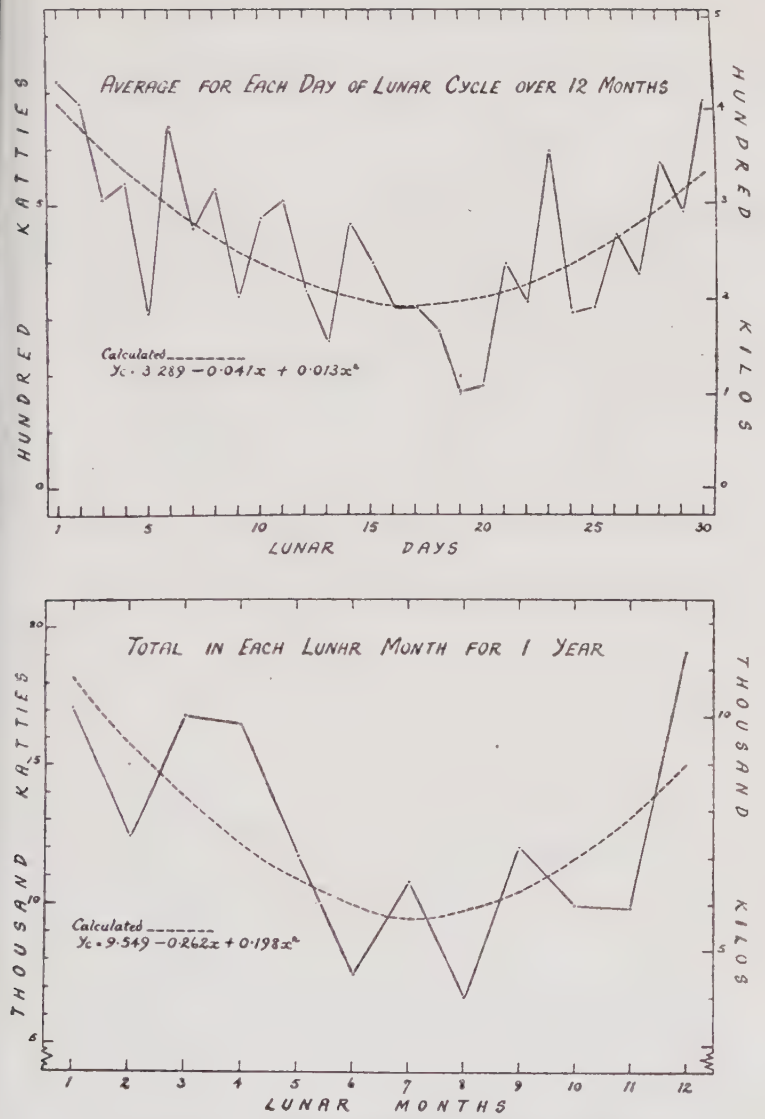
The handlings of different species are represented in graphs 13 to 20 in each of which the lunar cycle is represented in the upper half of the diagram and the seasonal cycle is represented in the lower half. It will be seen that the lunar cycle for *chencharu*, *kembong*, *merah*, *tenggiri* and *parang* conforms to the overall cycle for total landings, that is, with a minimum corresponding to the full moon. The cycle for *pari*, *terubok* and *kurau* is the reverse, showing a maximum corresponding with the full moon. Although regression curves of second degree have been calculated for each of these, certain of them, namely *pari*, *chencharu*, *kembong* and, perhaps *merah*, show rather erratic fluctuations about the regression line. The others, however, show fairly regular fluctuation which conceivably has the close relationship with tidal variation referred to above. This is very strikingly shown as an inverse relationship for *kurau* in which there are minima, at each end of the period and in the centre, corresponding to the tidal maxima and two maxima corresponding to the tidal minima. For *parang*, on the contrary, there is a very close direct correspondence with tidal variation, with maxima and minima corresponding to these points in the tidal curve. This is true also for *tenggiri*. Considering next the seasonal cycle, it will be seen that for most of these species the regression line can be calculated with reasonably good fit. This is especially true for *terubok*, *tenggiri* and *kurau*. It will be seen that second degree regression curves have been calculated and for certain species there are distinct maxima and minima apart from these curves.

The foregoing discussion of the species variation in availability merely serves to indicate the main features of this variation. It does not consider the causes underlying variation. These causes are technological and biological as discussed above in connection with variations in overall supply. From the biological point of view such fundamental analysis will involve much research work but already some results are to hand indicating the relationship between the behaviour of the fish (and therefore their availability) and environmental factors such as temperature, salinity and food supplies. The results of this work should be drawn into the present programme at the earliest opportunity.

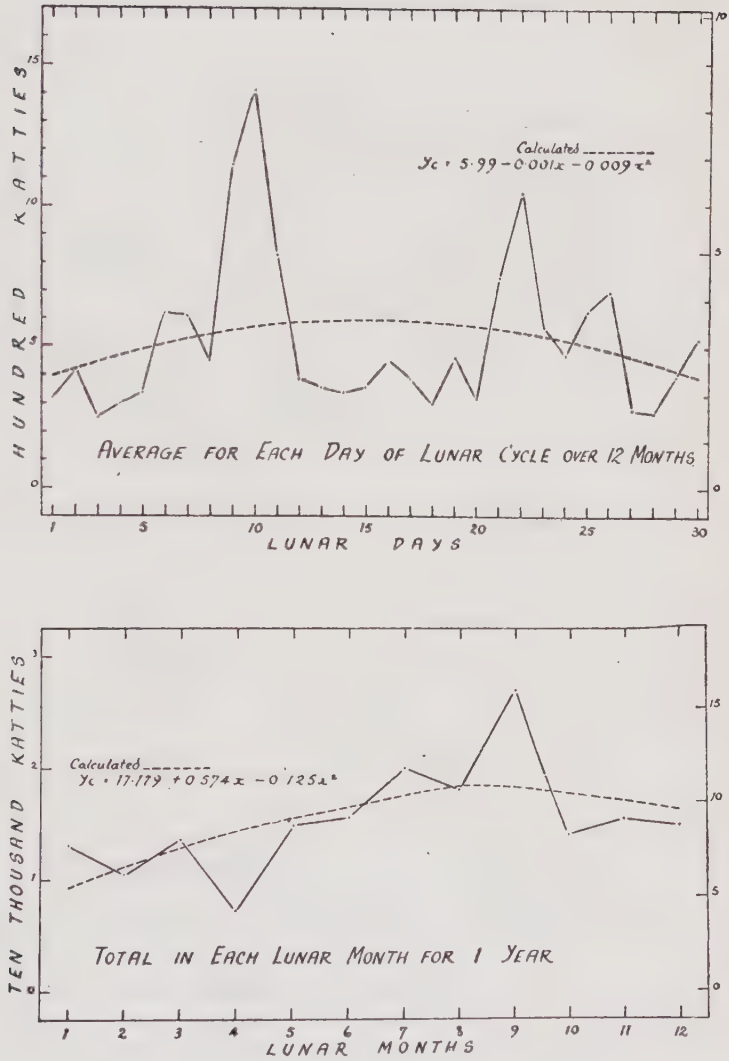
The above account of the total supplies available to the Singapore market very briefly and generally indicates the principal statistical features of these supplies. It is remarked above that these include a dominant upward secular trend, a double maximum seasonal fluctuation within each year, a lunar periodicity, a correlation with the tidal variation and an erratic diurnal element. These features express the operation of a great many factors, some of which are internal to the production phase of the industry and others are external to that phase. The lines along which the effect of the internal factors might be investigated and of the type of results which might be expected are given in section 4·3



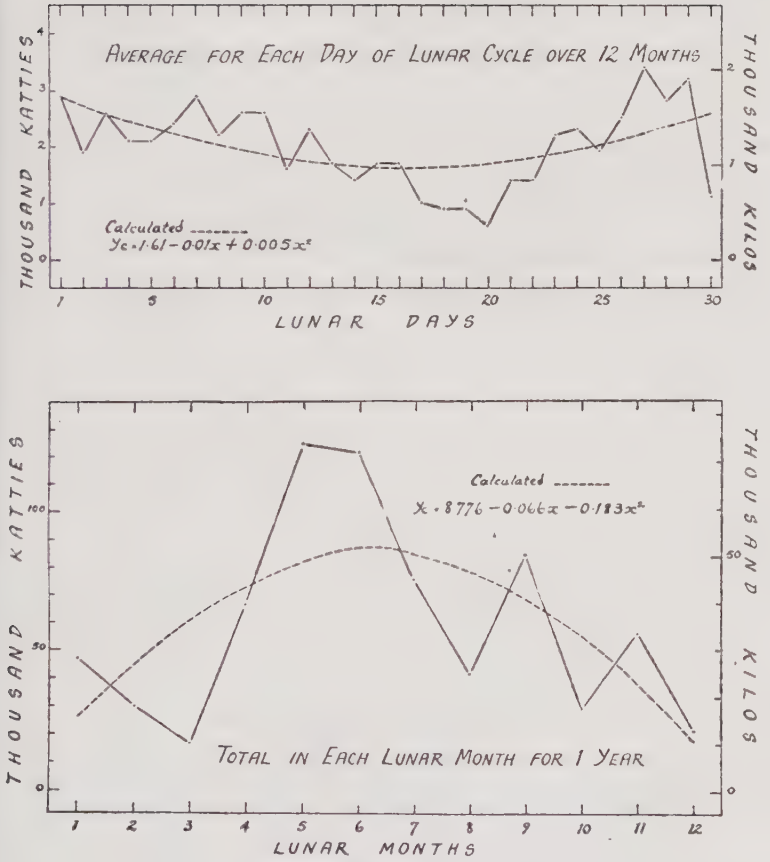
Graph 13. *Pari* HANDLINGS IN MUNICIPAL MARKETS
A. Average for each day of Lunar cycle over 12 months ending 5-2-51
B. Total in each Lunar month for one year ending 5-2-51



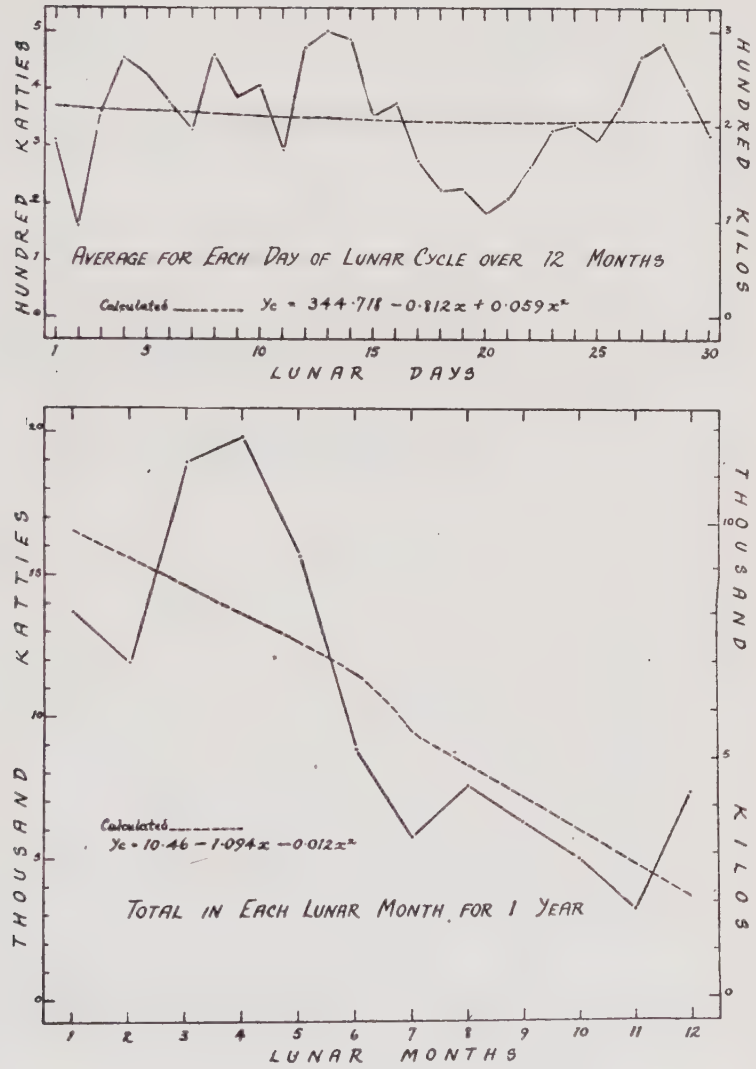
Graph 14. *Chencharu* Handlings in Municipal Markets


HUNDRED KATTIES
HUNDRED KILOS
Calculated
Yc = 5·99 − 0·001x − 0·009x²
AVERAGE FOR EACH DAY OF LUNAR CYCLE OVER 12 MONTHS
LUNAR DAYS
TEN THOUSAND KATTIES
Calculated
Yc = 17·179 + 0·574x − 0·125x²
TOTAL IN EACH LUNAR MONTH FOR 1 YEAR
LUNAR MONTHS

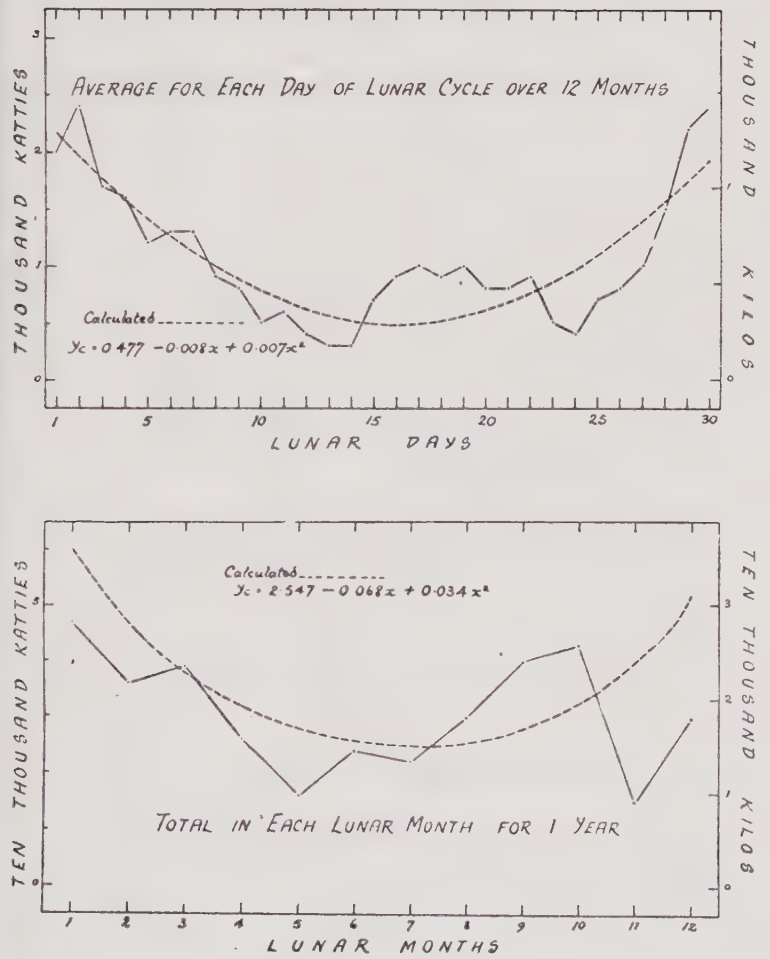
Graph 15. *Terubok* Handlings in Municipal Markets



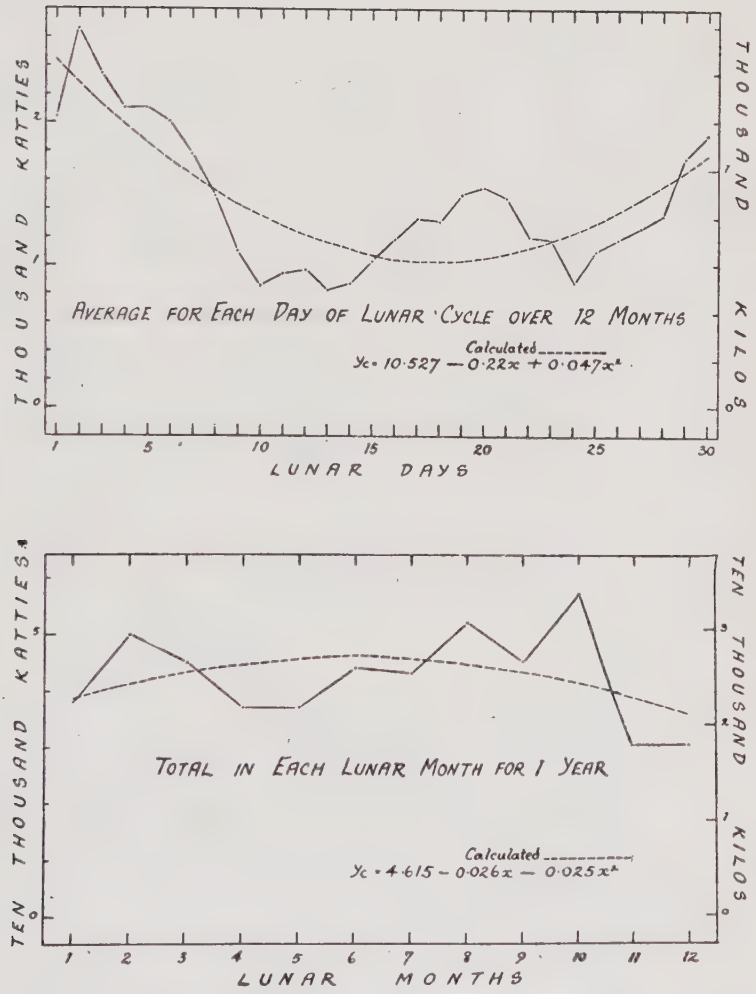
Graph 16. *Kembong* Handlings in Municipal Markets


HUNDRED KATTIES
HUNDRED KILOS
AVERAGE FOR EACH DAY OF LUNAR CYCLE OVER 12 MONTHS
Calculated ..... Yc = 344·718 − 0·812x + 0·059x²
LUNAR DAYS
THOUSAND KATTIES
THOUSAND KILOS
Calculated .....
Yc = 10·46 − 1·094x − 0·012x²
TOTAL IN EACH LUNAR MONTH FOR 1 YEAR
LUNAR MONTHS

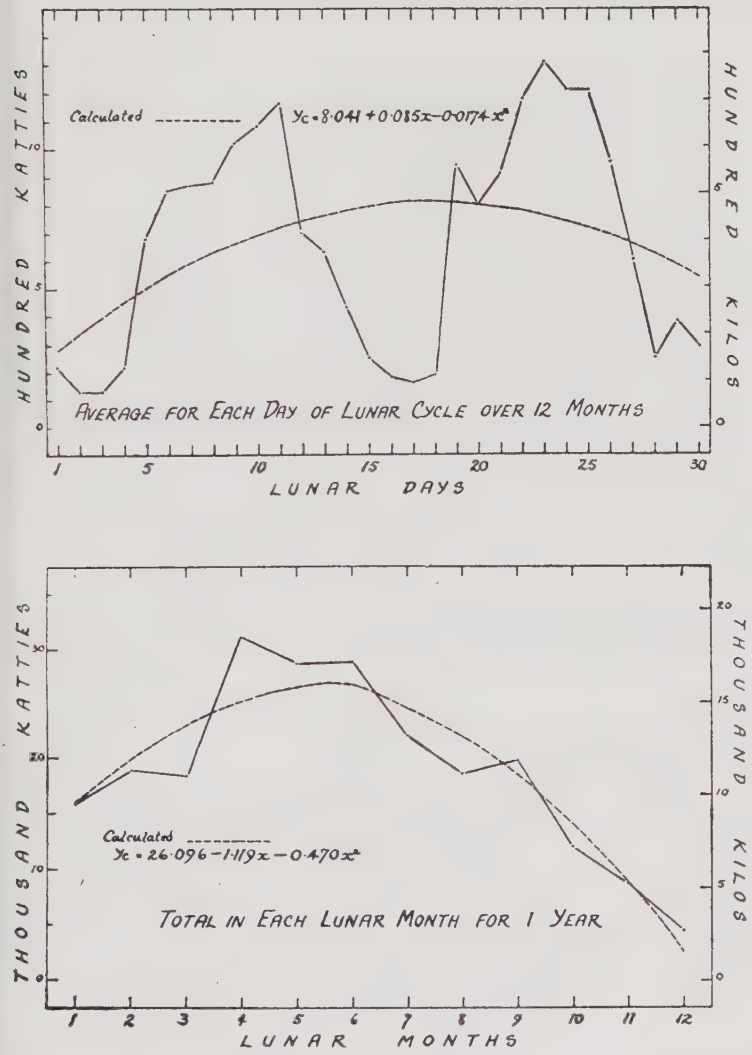
Graph 17. *Merah* Handlings in Municipal Markets


AVERAGE FOR EACH DAY OF LUNAR CYCLE OVER 12 MONTHS
THOUSAND KATTIES
THOUSAND KILOS
Calculated
Yc = 0·477 − 0·008x + 0·007x²
LUNAR DAYS
TOTAL IN EACH LUNAR MONTH FOR 1 YEAR
TEN THOUSAND KATTIES
TEN THOUSAND KILOS
Calculated
Yc = 2·547 − 0·068x + 0·034x²
LUNAR MONTHS

Graph 18. *Tenggiri* Handlings in Municipal Markets


THOUSAND KATTIES
THOUSAND KILOS
AVERAGE FOR EACH DAY OF LUNAR CYCLE OVER 12 MONTHS
Calculated
Yc = 10·527 − 0·22x + 0·047x²
1 5 10 15 20 25 30
LUNAR DAYS
TEN THOUSAND KATTIES
TEN THOUSAND KILOS
TOTAL IN EACH LUNAR MONTH FOR 1 YEAR
Calculated
Yc = 4·615 − 0·026x − 0·025x²
1 2 3 4 5 6 7 8 9 10 11 12
LUNAR MONTHS

Graph 19. *Parang* Handlings in Municipal Markets


HUNDRED KATTIES
HUNDRED KILOS
Calculated ----------
Yc = 8·041 + 0·085x − 0·0174x²
AVERAGE FOR EACH DAY OF LUNAR CYCLE OVER 12 MONTHS
LUNAR DAYS
THOUSAND KATTIES
THOUSAND KILOS
Calculated ----------
Yc = 26·096 − 1·119x − 0·470x²
TOTAL IN EACH LUNAR MONTH FOR 1 YEAR
LUNAR MONTHS

Graph 20. *Kurau* Handlings in Municipal Markets

in relation to the local supplies in respect of which a more detailed examination is possible. At this stage attention may be directed to a consideration of the factors external to the production phase which have an influence on the movement of supplies to the Singapore market as distinct from other available markets.

The effect of political factors in this complex is undoubtedly quite considerable. There is no doubt that the increase in supplies, between 1927 and 1938, resulted from the activities of the Japanese particularly in the operation of the *moro-ami* net in the territorial waters of adjacent territories. The post-war decline in supplies has been due to the fact that the local operations and those of the fishermen do not compensate for this lack of Japanese supply. Unfortunately the closure of the territorial waters of most adjacent territories to the few licensed *moro-ami* units in this Colony has effectively prevented the development of this important fishery by local personnel and the fishermen of the territories concerned are almost entirely unskilled in this particular method. In addition, although supplies from Indonesia have always played an important part in the market supplies of Singapore, these too have been reduced because of political considerations. As a result the Colony has become more dependent upon imports from adjoining British territories and upon the operations of its own fishermen. Imports have been increased, particularly from the State of Johore, but much has yet to be done to bring the supplies to the required level. Moreover, in recent months there has been serious interference in supplies from this source which can be attributed to the measures necessitated by the disturbances in Southern Malaya. This emphasizes the need for increased production by local fishermen and clearly both short and long term programmes of development must be directed towards this object.

Considerations of transport facilities and costs, collection arrangements, strength of the demand by various markets are involved in these problems along with the fundamental questions of natural abundance of fish and the efficiency of the fishermen. It will be necessary to consider some of these other factors, in the following two sections, before proceeding further with an attempt to forecast the developments which might take place in the overall supplies.

4.3 ESTIMATION OF PRODUCTION AND DETERMINATION OF THE FACTORS AFFECTING PRODUCTION

The data on market handlings (Series G (*a*)) include information on the handling of locally produced supplies but there is no past series on local production. It is possible that the present programme will gather information which will permit the use of the existing market handlings series as a basis for back extrapolation for estimate of local production but such a step is impossible in the present condition of our knowledge.

Since there is no comprehensive system of reporting of catches by the operatives and since, because landing points are so numerous and diffuse, it would be too expensive to station departmental officers to observe and record all landings, therefore the only estimate which can be obtained at this stage must be drawn from a sampling programme. The method to be employed proceeds through the following stages:—

(1) Inventory of the factors of production.

(2) Estimate of the operation of the factors of production, by sample.

(3) Estimate of the yield per unit effort from a sample of the units of equipment.

(4) Estimate of the total production, by proportion from the sample to the total amount of operation.

For the discussion which follows reference should be made to figure 4 which indicates the relationship between the various factors which influence the operation of the factors of production (designated briefly as 'fishing intensity'), the availability of fish to the fishing equipment and various sets of external factors.

The latest tabulations of the inventory of equipment are given in Tables III and IV; the areas in which these gears are used are reported in the following notes which also indicate the extent to which certain of the gears are moved about from point to point. The latter consideration has important bearing on the estimate of the operation of the factors of production.

1. *Fixed Gears.*

The following gears are fixed:—

(*a*) all fishing stakes, e.g. *kelong*, *kelong kawait*, *kelong bilis*, *belat*, *belat bubu*;
(*b*) prawn pond nets;
(*c*) *ambais*.

2. *Minor Methods of Fish Capture.*

The following gears are used in the locality of the village in which the operator resides and or returns to daily.

Spears, the manual collection of fish including shell-fish, *bubu empang*, most *bubus*, all small drift-nets excluding *jaring hanyut* and the Chinese *jaring selangat*, tangle nets, *hintur*, *angkul*, *sondong*, *sauk*, *jala*, *panching*, *pelontang*, *chandat*, *joran* and most *rawei umpan*. A number of these gears are subsidiary methods only, e.g. *sondong*, *sauk*, *chandat*, etc.

3. *Empang* (Set-barrier).

The *empang* is used in a wider area than the village of licensing, units employing this gear can be divided into three groups as follows:—

(*a*) those operating only in the vicinity of the base;
(*b*) those operating in the Eastern Straits of Johore; and
(*c*) those operating in the Western Straits of Johore.

In the former case the unit returns to base daily but in the case of those licensed in the Johore Straits, the gears may operate over a wide area including the coast of Johore and may stay in any one locality for two to three days.

4. *Bubus* (Fish-pots).

Fish-pots are generally worked in the vicinity of the village of licensing (i.e. village of residence of fishermen) but the *bubu laboh* (deep-water fish-pot) is worked up to ten miles from the island on which the fisherman resides. The catch is landed at the base.

5. *Jaring hanyut* (*Tenggiri-parang* drift nets).

This gear is operated in the general locality of the area of licensing and fish is landed at the base village. The units can be grouped into two areas as follows:—

(*a*) East Coast Road Area. (Kallang to Changi);
(*b*) West Coast Road Area and adjacent islands. (4½ milestone West Coast Road to Tuas.)

The former operates almost exclusively in the Main Straits but a few units transfer to the second area for the whole fishing period if the season is favourable there. The West Coast Area units also operate in the Main Straits off Raffles Light and Sultan Shoal, but occasionally units transfer to the Karimoen Islands and remain there for at least one fishing period (approximately 10 days). During this time they sell their catch in the Karimoen area and do not return to base.

6. *Chinese jaring selangat* (Drive-in gill net).

A few Chinese *jaring selangat* units operating at Mata Ikan Village may operate in the eastern entrance to the Straits of Johore. Their catches may be landed and disposed of in the area of operations but the units return to their base village at least every second day.

7. *Moro-ami units* (Japanese drive-in net).

These units are based on the town area and are towed to the fishing grounds by parent vessels. The unit then remains at the grounds and the carrier vessels operate a shuttle service back to the market.

8. *The Pukat tarek* (Beach seines).

The *pukat tarek* operate over a wide area around the village in which the fishermen reside. Four homogenous areas can be demarcated as follows:—

(*a*) East Coast Road excluding Kallang area—operating over whole of East Coast of Singapore;
(*b*) Kallang area—operating in Kallang estuary and also at Pulau Batam (Indonesia);
(*c*) Eastern Straits of Johore—operating in Eastern Straits and the Johore River Estuary;
(*d*) Western Straits of Johore—operating in the Western Straits and also in the approaches to the Straits in the Colony and Johore waters;
(*e*) West Coast Road area—operating in immediate vicinity of village of residence.

Landings are made from these areas as follows:—

(*a*) usually at village of residence but fish may be sold at point of capture;
(*b*) at Clyde Terrace Auction Market;
(*c*) at village of residence;
(*d*) usually at village of residence but a few units also land fish in Johore (fishermen are residents of that State);
(*e*) at village of residence;

9. *The Pukat payang* (Singapore sunken boat-seine).

The *pukat payang* is operated during the months November to March by migrant fishermen from Kuala Sedili. The units (4) operate in the Main Straits and return to their base village every day. Fish is landed there or at Marine Parade auction point but since only four gears are operated, complete records can be maintained for this gear.

10. *The Panching tunda* (Troll-line).

The *panching tunda* is operated by local fishermen on their way to the fishing grounds and commercially by powered vessels in the South China Sea and the Indian Ocean. In both cases the catch is landed at the base point.

11. *Summary.*

(*a*) The following gears are local in use and fish is landed at village of residence of the fishermen:—

Serampang (spears), manual collection, *bubu empang* (fish-pots with wings), most *bubus* (fish-pots), all small *jaring* (drift-nets) excepting *jaring hanyut*, the *jaring ketam* (crab tangle-nets), *bintur* (crab lift-nets), *tangkul* (lift-nets), *sondong* (push-nets), *sauk* (dip-nets), *jala* (cast-nets), *panching* (hand-lines), *joran* (rod and line) and *rawei umpan* (baited long-lines).

(*b*) The following gears may vary in area of operation but their catches are landed at the same point, either the area on which the boat is based or at a specific collecting landing point.

Empang (barrier-nets), *bubus* (fish-pots) other than in (*a*), most *jaring hanyut* (drift-nets) and Chinese *jaring selangat* nets, *moro ami* nets, *pukat payang* (for 4 months) most *pukat tarek* and all *panching tunda* (troll-line) units.

(*c*) The following may move to new areas and land their fish there in certain seasons:—

Some *jaring hanyut* operators from the West Coast Road area and adjacent islands, the *pukat tarek* units based at Kallang and the *pukat payang* units (these units only visit the Colony for 4 months in the year).

(*d*) The following gears are 'semi-permanent' structures and if they are moved this is done only with the approval of the Fisheries Department:—

(i) All fishing stakes;
(ii) Prawn pond nets which are used in conjunction with cultural operations.

It will be clear from the above that each of these groups of gear will require different treatment in the sampling programme, more especially in relation to the estimate of fishing effort. Both inventory of equipment, and the frame of reference against which the operations of the equipment must be sampled, must be treated as variable. This of course adds to the complexity of the sampling programme which is basically complicated in many ways especially, from the present point of view, by the different numbers of units of gear and their different efficiencies which render one type more important than another. Among the types of gear in use, the *kelong* is of overwhelming importance and initial studies show that this gear is employed for the capture of approximately 70 per cent of the total commercial catch. This fact obviously has very great significance in connection with this part of the survey programme because the accuracy possible in the estimate of the *kelong* catches (because of the fixity of the gear,

Table X

SUMMARY OF FISHING UNITS UNDER SURVEY, 1950–1951

I. Fishing Stakes

Name of Gear and Locality of Operation	Total No. of Gears Licensed	Sample	Per cent
A. *Kelongs*			
Area I E. East Coast Road Area—Tanjong Rhu to Eastern Tekong	78	30	38
Area II E. Johore Straits—Western Tekong to Ponggol	61	14	23
Area I N. Johore Straits—Seletar Area ..	18	10	55
Area I W. West Coast Road Area	20	10	50
Area II W. Tuas Area	33	8	24
Area II N. Western Johore Straits ..	14	5	36
Total ..	224	77	29
B. *Blats*			
Colony of Singapore and adjacent islands ..	116	35	30

IIA. Other Gears (By type of Gear)

Name of Gear	Total No. Licensed	Sample	Per cent
Pukat tarek	77	38	49
Prawn pond net	196	17	9
Moro ami	3	3	100
Pukat gonggong	5	0	0
Pukat payang	4	4	100
Pukat jerut	1	0	0
Floating trawl	2	0	0
Jaring hanyut	255	38	15
Jaring selangat	13	11	85
Jaring ketam	24	8	33
Jaring karang	11	2	18
Jaring tenggelam	2	1	50
Tangkul	15	4	27
Sondong	31	1	3
Rawai umpan	36	4	11
Bubu laboh	24	1	4
Bubu	106	21	20
Bubu karang	17	5	29
Bintur	5	3	60
Enjab	17	2	12
Ampang	15	8	53
Bubu ampang	6	5	83
Total ..	865	176	20

Table X—*continued*

SUMMARY OF FISHING UNITS UNDER SURVEY, 1950-1951—*continued*

IIB. Other Gears (Total by Villages)

Name of Village or Base	Total No. of Gears Licensed	Sample	Per cent	Per cent
Town Area	12	1	8.3	9.1
Kallang Area (including Pulau Minyak and Geylang)	43	4	9.3	
Kampong Amber	..	..	..	
Katong Area	23	16	69.6	32.3
Kampong Siglap (including Frankel Estate)	57	7	12.3	
Kampong Bahru (Siglap)	30	10	33.3	
Kampong Bedok	6	2	33.3	
Kampong Padang Terbakar	12	4	33.3	
Kampong Telok Mata Ikan	17	8	47.0	
Kampong Ayer Gemuroh	10	3	30.0	
Kampong Changi	4	3	75.0	
Pulau Tekong (Besar and Kechil)	37	7	18.9	23.1
Pulau Ubin	11	2	18.2	
Upper Serangoon Area	15	7	46.6	
Ponggol Area	52	36	69.2	55.2
Seletar Area (including Tanjong Irau and Kampong Seletar)	24	8	33.3	
Kampong Woodlands and Kranji	5	2	40.0	
Lim Chu Kang	2	..	..	
Choa Chu Kang and Bajau	2	1	50.0	
Tuas	59	..	..	
Pulau Semulun	16	..	..	
Tanjong Kling	7	1	14.3	5.3*
Damar Laut and Damar Darat	7	..	..	
Tanjong Penjuru	12	..	..	
Sungei Jurong to West Coast Road Area	136	13	9.6	
Pasir Panjang Area	39	..	..	
Pulau Seraya	21	1	4.8	
Pulau Ayer Chawan	1	..	..	
Pulau Ayer Merbau	7	..	..	2.7*
Pulau Pesek	1	..	..	
Pulau Merlimau	7	..	..	
Pulau Bukom Kechil	44	12	27.3	
Pulau Semakau	9	7	77.8	
Pulau Seking	18	..	..	27.6
Pulau Sudong	22	17	77.3	
Pulau Sekijang	31	1	3.2	
Pulau Brani	9	..	..	
Powered Fish Carriers	12	3	25.0	
Other Areas: (*a*) Johore	40	..	..	
(*b*) Indonesia	5	..	..	
Total	865	176	20.3	

*Low sample due to difficulty of access.

N.B.:—Grouping in extreme right hand column represents homogenous geographical areas.

geographically and structurally) gives a measure of accuracy to this large proportion of the catch which permits of wider margins of error in the estimates of production of other gear types without impairing the overall level of accuracy. Table X gives a summary of the numbers of units of gear under observation for this project of estimation of gear operation and production; the table shows both the actual numbers under observation and the proportion which they hold to the total number of units in each village. It will be seen that the sample proportion is extremely variable; this is a result of necessity and it is probable that substantial changes must be made in this sampling schedule in the interests of both economy and efficiency. Very roughly these sample sizes have relation to the relative magnitude of the catch taken by the respective gear types, but this can undoubtedly be improved and advantage can be drawn by bringing the sample fraction into better relation with the variance of the catch from each type. This aspect is discussed below.

The sampling methods employed in this section are discussed in Appendix II and it is mentioned there that, at this stage, duration of operation is taken to be a standard amount for each type of gear and is indicated merely as days-of-operation. That is to say, a trap will capture fish (with varying efficiency from hour to hour, depending upon the principle of its operation) for the whole of the period of its immersion, and although records frequently relate to catches taken over two or more days, the trap having been left unattended for that time, nevertheless, such catches are treated equally with the others; this is necessitated by the fact that, whilst it is known that such two-day and three-day landings may occur, there is no method yet of keeping accurate check on such variations. Similarly with other types of gear, one fisherman may operate the gear for more hours on each day on which he goes to sea than others do on their days of work; but all days of work reported are counted equal. Finally, the time (during hours of light or dark) of operation of movable gears and the proportion of such hours spent in working tends to be a characteristic of gear types at least in major categories. Nevertheless frequency of operation, that is, the number of days on which it is employed, is obligatorily the measure of fishing effort. For the present stage, when an effort is being made to derive an understanding of the 'behaviour' of the catch statistics (in the course of which the importance of each gear type as a variate is chiefly in respect of its contribution to the total catch) the variation in effort within each gear type is not of very great importance. But when the analysis of production is pressed further it will be necessary to obtain more precise measure of fishing effort and of its variation from one gear type to another; at such time, the first step will be to measure the actual hours, or days, of operation related to each recorded catch.

In the present phase of work, record is kept of the days of operation of the units of gear in the 'sample' under observation. Actually this is a day by day record, and for each day a calculation is made in the simple proportion, $a:b::A:B$, where a is the number of sample units operated on the day in question, b the number of units in the sample, A the estimate of all units operated from among B, the total number of units in the locality. This estimate of the total number of units operated on each day is an important element in the argument, and whilst there are reasons for believing that the results obtained to date are reliable, steps are being taken to test this reliability.

Record is kept of the catch of each of the units of gear which constitute the sample and the average catch per unit is calculated. By simple multiplication of this average by the total of units in the locality (from which the sample is taken), an estimate of the total production by these units is obtained. Examples of the entire operation are given in Tables XI and XII. The reliability of this estimate may be tested in two ways. The first, and most obvious approach is by way of comparison with data on the quantities of locally caught fish entering

Table XI

ESTIMATED LOCAL PRODUCTION

(Jan. 1951)

Pukat Tarek

Singapore; Licensed Gear 77: Gear Sample 25

1951 Jan.	GEAR USAGE		YIELD (In katties)			
			SAMPLE (In katties)		TOTAL CALCULATED (In katties)	
	Sample	Total calculated	Human Consumption	Manure and Pig Food	Human Consumption	Manure and Pig Food
1	22	67.8	613	221	1,888	681
2	17	52.4	395	183½	1,217	565
3	14	43.1	240	174	739	536
4	15	46.2	298½	202½	919	624
5	16	49.3	356½	125	1,098	385
6	21	64.7	655	66	2,017	203
7	23	70.8	891	322½	2,744	993
8	21	64.7	719½	328	2,216	1,010
9	21	64.7	854	472½	2,630	1,455
10	18	55.4	665½	335½	2,050	1,033
11	22	67.8	726½	973½	2,238	2,998
12	18	55.4	563	294	1,734	906
13	15	46.2	377	405½	1,161	1,249
14	21	64.7	421	318	1,296	979
15	12	37.0	192½	118	593	363
16	16	49.3	303	84	933	259
17	12	37.0	248	77½	764	239
18	13	40.0	197	116½	607	359
19	17	52.4	340	94	1,047	290
20	18	55.4	506	204	1,558	628
21	18	55.4	537½	202½	1,655	624
22	21	64.7	621	153	1,913	471
23	21	64.7	763½	212	2,352	653
24	20	61.6	832	198	2,563	610
25	22	67.8	699½	322½	2,154	993
26	23	70.8	932	388½	2,871	1,197
27	23	70.8	763	388	2,350	1,195
28	24	73.9	933	567	2,874	1,746
29	22	67.8	1,048½	407	3,229	1,254
30	21	64.7	596½	318½	1,837	981
31	13	40.0	262½	260½	809	802
Total	580	1,786.5	17,551	8,533	54,058	26,281

The number of gears in the area is determined from the inventory and the number which submit returns is shown as the gear sample. From these returns the number of gears in use each day is compiled—Gear usage (Sample). Yield for the sample is also calculated and shown as 'Yield (Sample)'. From the gear usage (sample) and knowing the proportion of the gear sample to the total number of gears it is possible to calculate the total gear usage:—

$$\frac{\text{Gear usage (sample)}}{\text{Gear sample}} \times \text{Total No. of Gears} = \text{Total Gear Usage (calculated)}.$$

Similarly

$$\frac{\text{Yield (sample)}}{\text{Gear usage (sample)}} \times \text{Gear Usage (calculated)} = \text{Yield (calculated)}.$$

With the calculated yield for each type of gear it is then possible to prepare estimates of total monthly production. (See Table XII).

Table XII

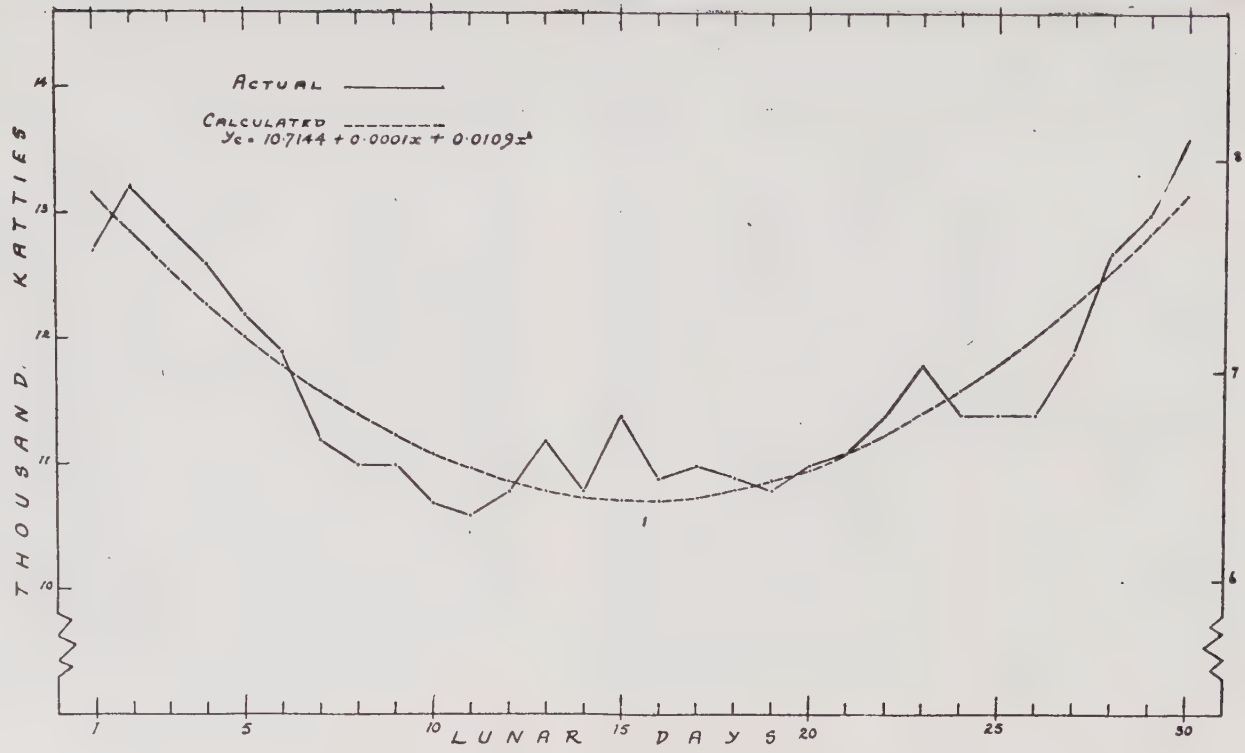
ESTIMATED TOTAL WET FISH PRODUCTION IN LOCAL WATERS (Weights in Katties)

Name of Gear	No. of Gears employed during month	Gear Sample	Average No. of Fishing days per gear (Calculated)	Gear Usage (Sample)	Gear Usage (Total Calculated)	YIELD (SAMPLE)		YIELD (CALCULATED)	
						Human Consumption	Manure and Pig Food	Human Consumption	Manure and Pig Food
1. *Kelong*									
Area I (E)	78	24	31.0	744	2,418	75,602	21,152	245,706	68,744
II (E)	61	10	30.4	304	1,854.4	13,020	10,201	79,422	62,226
I (N)	18	8	30.3	242	544.5	2,967	3,895	6,675	8,763
I (W)	20	10	24.6	246	492	6,410	2,327	12,820	4,654
II (W)	33	3	31.0	93	1,023	4,290	1,049	47,190	11,539
II (N)	14	2	31.0	62	434	696	634	4,872	4,438
Sub-total ..	224	57	—	1,691	6,765.9	102,985	39,258	396,685	160,364
2. *Jaring hanyut*	255	10	11.8	118	3,009	1,827	..	46,588	..
3. *Pukat tarek*	77	25	23.2	580	1,786.5	17,551	8,533	54,058	26,281
4. *Bubu*	147	12	14.8	177	2,168.25	1,454	121	17,811	1,482
5. *Empang*	14	7	19.4	136	272	4,508	1,328	9,016	2,656
6. *Jaring selangat* (including *jaring tenggelam*)	15	5	19.8	99	297	1,176	37	3,528	111
7. *Pukat payang*	4	2	19.5	39	78	5,310	420	10,620	840
							Total ..	538,306	191,734
							Long Tons ..	320.42	114.13
							Daily Average (Long Tons) ..	10.34	3.68

the marketing system, but it must be kept in mind that one of the problems of this survey arises out of the fact that undoubtedly significant quantities of this locally caught fish do not pass through the marketing system, and these quantities vary from time to time according to the magnitude and composition of the catch and the state of the market. However, some comparison can be made, as shown in graph 21, in which the upper line represents the estimate of production and the lower lines the handlings at various markets with a total for the Colony. The data of the upper line were provided by this organized system of estimate only for the last three months of the year, the data of the first nine months were the result of a smaller, much rougher system of estimate. The high yield of the penultimate month, marked by the peak of this graph, is known to have been caused by large catches of *bilis* which appeared in all markets; it therefore casts no doubt on the general series of estimate and one may give some attention to the similarity of level of estimate from the earlier, small system, and the current system. Among the possibilities which spring to mind, one may consider it likely that the success of the earlier system indicates that no improvement in the estimate has been obtained by the expansion of the sample frame and size; this, however, must be thoroughly tested, and it will appear in the second of the tests of reliability of the estimate referred to above. This second test would follow the classical lines of tests of significance and will involve calculation, as accurately as possible, of the variance of the estimate, as a total and in its various components. This test will have two products: firstly, it will permit the presentation of an estimate of the limits within which probably the real total landings lie (the earlier test cannot give a quantitative measure of this); secondly, it will permit estimates of the optimum frequency and size of samples which should be taken to give an estimate lying within certain probable limits. The expression 'optimum' relates both to economy and efficiency in the sampling programme. So far as efficiency is concerned the main consideration is the variance, and there are ample data already collected to show that this differs widely with gear type, locality, season and other factors. Some of the preliminary results in measurement of the variance due to different factors, and the conclusions drawn therefrom as to sample frequency and size, are given in Appendix II.

The foregoing discussion considers the statistics of production in relation to the economic factors, internal and external to the industry, which affect production. It does not properly consider the biological and related environmental factors which affect production although, insofar as the analysis recognizes the relationship in a time series between production and certain dominant meteorological factors, it touches upon the fundamental question of availability of fish to the fishing operations. Turning again to figure 4, it will be seen that the principal line of argument commences with the natural fish stocks which, depending upon the operation of various factors which influence the behaviour of the fish, present a certain proportion as available to the fishing operations. The quantity of fish which is taken from the available fish stocks depends upon the quantity and the intensity of the fishing operations. This depends, of course, on the numbers of men and boats and on environmental conditions (weather, etc.) as well as on economic conditions including demand for fish and the technical facilities for making potential demand an effective one; the last step, from production to actual supply, is represented in figure 5. Now, the really fundamental questions are those concerning the abundance of the natural stocks, how this is determined and the factors which determine the availability of these stocks to the fishing operations. Apart from tentative correlations with major meteorological factors, it is beyond the competence (and the staff and equipment) of the Survey to attempt any study of these questions for this is a task to be undertaken by fishery biologists and other scientific staff who will,

Graph 21. Estimated Monthly Production and Monthly Total Market Handlings of Local Origin (1950)



Graph 22. Lunar Mensal Average Daily Market Handlings of Local Origin for 4 Lunar Years

wever, lean heavily on the Survey for data concerning fishing operations and oduction. However, a substantial beginning has already been made by the search Officer (Marine), Federation of Malaya and Colony of Singapore. o, from a study of the hydrology and planktology of the Singapore Straits, conjunction with data on meteorological factors, has analysed the catches en from representative units of fishing gear in the Straits and has proposed equation in which the catch is related to selected critical factors. At the sent stage this constitutes a useful analysis of the variations in availability of to these gears and will lead directly into the examination of real levels of ndance. The equation which has been evolved represents only a direct relation of contemporaneous series—some further work will undoubtedly vert this into a means of prediction. However, in its present state it can be lied to the available series of the Survey to constitute a supplementary ns of checking the survey estimate of production.

It will be seen that there are two independent lines of argument. The first sists of the study of production in the four stages described above which, appropriate examination of the economic factors of production furnishes understanding of production as an economic phenomenon alone. The nd line, followed by the Research Officer (Marine), directs attention upon resource itself and the factors which influence the abundance of the stocks the availability of the stocks to the fishing operations. The argument then s to the results of representative fishing operations to measure (*a*) the tionship between the determined availability and the catch per unit effort, he response of the fishing operations, in terms of changes in intensity and iency, to changes in availability of the fish. From these results this argument s to a system of prediction of availability of fish and of yield. The first line rgument cannot give a reliable prediction system by itself, but it can con- ute to the argument of the second line of argument. However, the first line gument does provide, as indicated above (and, on a different set of data, ction 4.2), a precise description of the usual behaviour of this system from h there emerges a reasonable expectation within certain limits. This point be returned to later.

ESTIMATION OF PRICE AND ASSESSMENT OF FACTORS AFFECTING PRICE LEVELS AT VARIOUS STAGES

In dealing with statistics of prices there are certain general considerations n must be borne in mind and to which attention should be drawn here. y, it is to be noted that there are two broad categories of 'price' statistics ne one hand, there may be available a real price obtained by calculations actual records of quantities of goods and money exchanged. On the other there will be prices which are merely quotations, reports, or impressions in fact are mere gossip as to the cost of fish at a certain time. Statistics two categories will obviously be of different value for statistical purposes nust be dealt with differently. Those of the first category relate to real ities of fish and of money, whereas those of the second are, at best, lly selected observations of an index and not of any quantities. This to the second point, namely that a 'price' is essentially an index, that is, a between two quantities, which in this case are of fish and money. For the ices mentioned above there is, by definition, a ratio between real, recorded ties whereas for prices of the second type there is usually no such record. eaning of a price of the second kind is 'on the day, or occasion, to which ord relates fish of the type concerned could be bought at about the price ; but as to how much money was altogether paid for this type of fish,

there is no information. The importance of this difference arises out of the two differing uses to be made of the statistics. Firstly, there is the econometric application in relation to the measurement of the forces of supply and demand. Secondly, there is the fiscal application in studying the industry's contribution to national income, the costs of production and distribution in the industry, and the distribution, within the industry, of its earnings. It will be clear that while statistics of the second category may perhaps be useful in econometric work, even if perhaps only in introductory studies, they will be of little real value for the second type of work unless gathered and treated with particular care.

From the statistical point of view there is a further consideration, namely that when a correlation is calculated between an index (= ratio) and one of the members of which it is a ratio, or even another element with which one of the members of the ratio is closely linked, there will be spurious correlation. The determination of relationship should, therefore, be made between the two quantities, and between their regression and other independent variables.

It will be seen from section 3 that there are many sets of statistics available concerning prices; the relative value of the different sets is discussed in section 3, and in section 2 there is a discussion of the methods employed in obtaining the data. These series are chiefly of the second category referred to above, and some are of greater length than others; in particular series I (*d*) ii extends from the beginning of 1947 to the end of 1950 and is in fact continuing. This series is given in Table XIII and is the source of data presented in graph 23A.

The series is described as monthly average prices obtained by averaging daily retail prices recorded by Municipal staff (Market Managers) from three or four stalls at each market. These prices are in fact quotations, being the price at which fish was offered. Although the recording technique was to some extent systematised, there was no 'control' over such factors as time of the day at which the record was taken, relation of the quality of the stock offered by these stalls to the quality of the stock offered elsewhere in the market, and so forth. The records have been further grouped into three principal quality categories, with the records relating to *kurau* maintained separately.

These data were first examined in February 1950 at which time the four sub-series all showed straight line relationships with time, and the fish supply showed at the same time a straight line regression. The regression coefficients were statistically significant and indicated that over the period the fish supply was increasing at the rate of 4.87 tons per month whilst the price of fish was decreasing at rates of 0.87, 1.71, 1.43 and 0.43 cents per *katty* for *kurau*, 1st, 2nd and 3rd quality respectively. Correlation between the deviations of supply from its regression and of the price of each category from the regression of its price showed significant relationship in all four correlation coefficients. These rates of decrease represented roughly 12 per cent, 2.5 per cent, 3.3 per cent and 2.3 per cent of the original price of these categories per month. Thus *ikan kurau* decreased 12 per cent in price in twelve months. However, these linear regressions were not maintained and during 1950 the prices once more began to increase so that at the end of 1950 the regression was best described as a quadratic, as shown in the graphs.

In such movements of prices it is to be expected that a number of components might be discernible, as was demonstrated in connection with the behaviour of the supply statistics. It was assumed that over a sufficiently long period it would be found that the prices held a steady level, or displayed a secular trend closely related to the prevailing economic conditions, relating chiefly to the purchasing power of the consumer. It has also been assumed that deviations from trend of the prices would correspond to deviations in availability and be correlative therewith. The graphs indicate that there are secular trends

in the price curves, and these are similar, not only for each of the four categories (graph 23) but also for individual species, as shown in the series of graphs 24–26. These regressions are at rates which do not correspond with the rate of change in supply and indicate that price changes are more strongly affected by the economic conditions than by the supply. In partial confirmation of this (to be more fully tested) graph 23 shows the relationship between price movement and the indices of trade with Indonesia and the price of rubber, both of which are good indicators of economic conditions for the Colony. The presence of fluctuations in price over the lunar period, corresponding inversely to the demonstrated changes in supply of such a period, is most markedly presented in respect of the individual species as shown in graphs 24 26. These graphs show the very interesting feature that the dominant movement of price is inverse to the total supply curve which, in some cases is opposite (that is, with maximum at a different time of the month) to the supply curve for the species; as a result, the dominant curve for some species is roughly parallel to its price curve giving, within the month, a higher price for greater supply. However, in all cases other than *ikan merah* the day to day deviations from regression are opposite as between supply and price of the species. Graph 27 shows the direct relationship between these deviations in the form of supply demand curves. The single exception is apparently the result of the popularity of this fish for contract supply, which leads to the presence of competing bulk purchasers when the quantity on the market is large.

It must be emphasized that the data analysed in the foregoing fashion are regarded as suspect and have yet to be tested. No definite conclusions have been drawn, therefore, but it seems fairly well demonstrated that (1) there probably exist secular trends related to prevailing economic conditions, (2) there are seasonal fluctuations (3) the lunar cycle of supply exercises a dominant influence on price, regardless of the variation in supply of the individual species.

Table XIII

MONTHLY AVERAGE DAILY RETAIL PRICES (1947 TO 1950)

	Bawal puteh	*Bilis*	*Chencharu*	*Kembong*	*Kurau*	*Merah*	*Parang*	*Pari*	Prawns (large)	*Selar*	*Tamban*	*Tenggiri*	*Terubok*
1947	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
January	3 05	0 68	0 70	*	2 20	1 50	1 50	0 40	2 70	1 50	0 30	1 80	0 79
February	3 00	0 73	0 70	*	2 00	1 50	1 50	0 40	2 70	1 50	0 30	1 62	0 73
March	3 47	0 65	0 50	*	1 92	1 35	1 38	0 30	2 57	1 50	0 30	1 65	0 60
April	3 20	0 60	0 50	*	1 95	1 50	1 30	0 30	2 60	1 50	0 30	1 80	0 60
May	..	0 47	0 50	*	1 80	1 35	1 20	0 30	2 60	1 50	0 30	1 44	0 60
June	2 33	0 39	0 40	*	1 80	1 30	1 20	0 25	2 30	1 30	0 25	1 30	0 55
July	2 62	0 39	0 40	*	1 78	1 30	1 20	0 25	2 30	1 30	0 25	1 30	0 60
August	2 48	0 39	0 40	*	1 65	1 30	1 20	0 25	2 30	1 30	0 25	1 22	0 60
September	2 33	0 41	0 51	1 03	1 53	1 25	1 08	0 30	2 33	1 20	0 48	1 27	0 68
October	2 23	0 51	0 68	0 99	1 70	1 22	1 17	0 36	2 45	1 25	0 53	1 29	0 71
November	2 52	0 53	0 67	1 20	1 75	1 35	1 10	0 40	2 47	1 29	0 28	1 38	0 68
December ..	3 08	0 45	0 70	0 93	1 71	1 27	1 25	0 36	2 46	1 32	0 32	1 46	0 61
Annual Average ..	2 76	0 52	0 56	1 04	1 82	1 35	1 26	0 32	2 48	1 37	0 32	1 46	0 65
1948	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
January	2 09	0 41	0 71	1 01	1 70	1 32	1 27	0 43	2 51	1 26	0 35	1 46	0 74
February	2 69	0 51	0 66	0 98	1 71	1 37	1 05	0 38	2 65	1 23	0 38	1 37	0 82
March	1 91	0 40	0 69	1 01	1 63	1 16	1 08	0 37	2 57	1 20	..	1 24	0 71
April	1 63	0 45	0 67	0 82	1 72	1 18	1 05	0 37	2 40	1 10	0 38	1 21	0 76
May	1 32	0 38	0 68	0 75	1 70	1 18	1 15	0 35	2 36	1 07	0 34	1 15	0 67
June	1 82	0 41	0 65	0 88	1 69	1 15	1 03	0 36	2 07	1 12	0 35	1 16	0 71
July	1 69	0 40	0 67	0 84	1 67	1 16	1 10	0 33	2 18	1 06	0 35	1 28	0 78
August	2 17	0 42	0 77	1 02	1 67	1 32	1 16	0 32	2 37	1 23	0 35	1 47	0 83
September	2 59	0 37	0 66	0 92	1 61	1 25	1 20	0 35	2 30	1 27	0 43	1 32	0 78
October	1 71	0 43	0 70	0 89	1 79	1 19	1 14	0 36	2 45	..	0 36	1 27	0 74
November	1 55	0 42	0 64	0 72	1 75	1 16	1 07	0 35	2 41	1 13	0 36	1 20	0 80
December	1 58	0 39	0 57	0 72	1 77	1 13	0 94	0 36	2 32	1 07	0 36	1 08	0 67
Annual Average ..	1 89	0 42	0 67	0 88	1 70	1 21	1 10	0 36	2 38	1 16	0 36	1 27	0 75

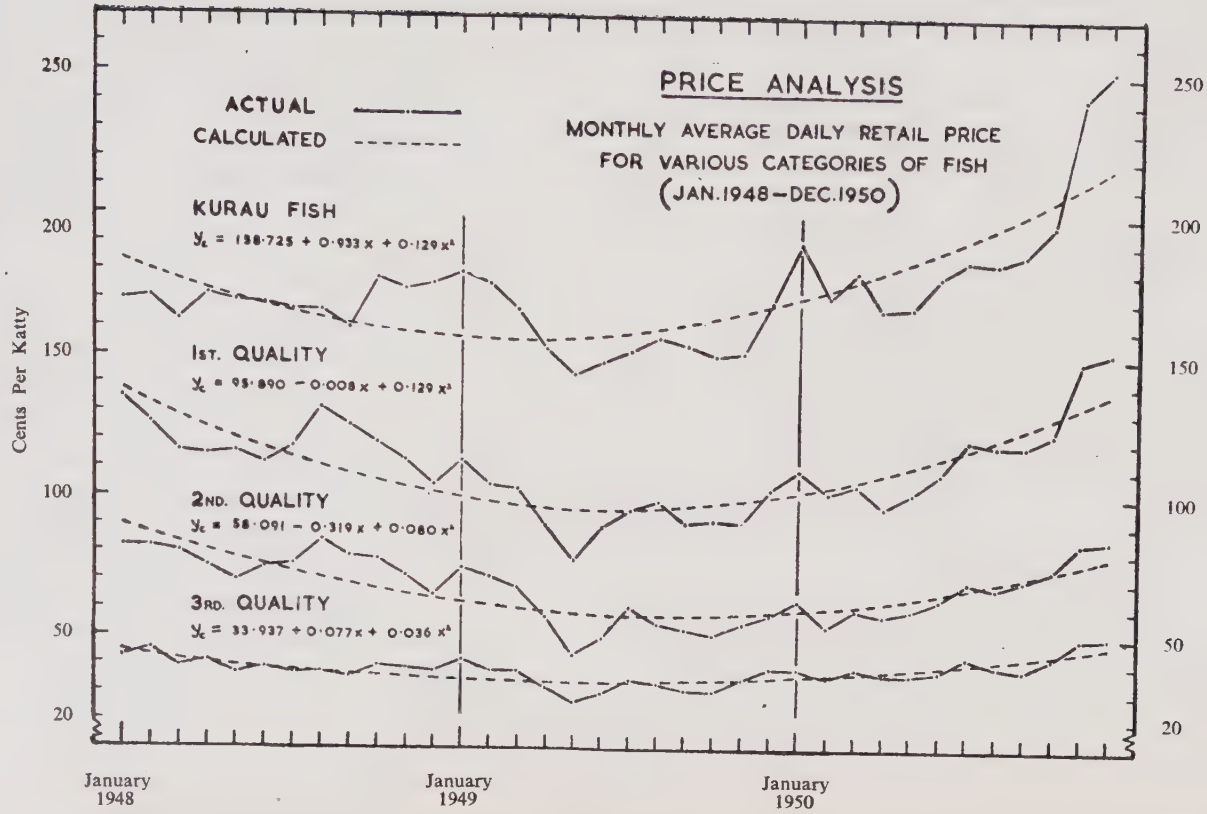
*No figures available.

Table XIII—*continued*

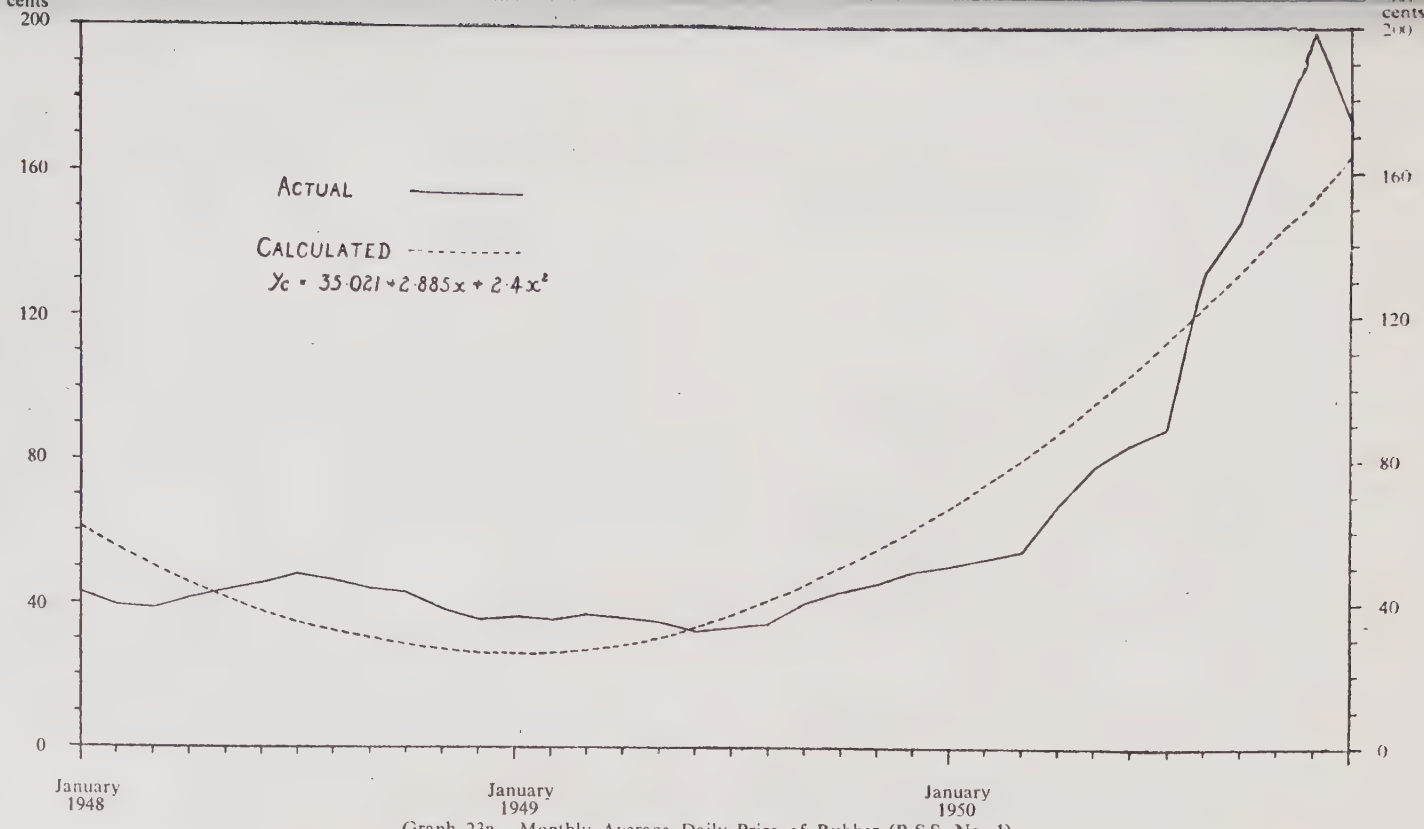
MONTHLY AVERAGE DAILY RETAIL PRICES (1947 TO 1950)—*continued*

	Bawal puteh	*Bilis*	*Chencharu*	*Kembong*	*Kurau*	*Merah*	*Parang*	*Pari*	*Prawns (large)*	*Selar*	*Tenggiri*	*Terubok*	*Gelama*	*Yu*	*Belanak*	*Bawal hitam*	*Senagin*	*Talang*
1949	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
January	1 63	0 41	0 61	0 92	1 81	1 11	1 10	0 42	2 54	*	1 21	0 71	*	*	*	*	*	*
February	1 61	0 35	0 62	0 87	1 77	1 07	0 97	0 41	2 30	*	1 10	0 67	*	*	*	*	*	*
March	1 38	0 38	0 54	0 88	1 68	1 10	0 97	0 38	2 27	*	1 05	0 63	*	*	*	*	*	*
April	1 31	0 33	0 50	0 68	1 54	0 95	0 87	0 31	1 95	*	0 92	0 57	*	*	*	*	*	*
May	1 18	0 28	0 42	0 43	1 45	0 83	0 69	0 25	1 89	*	0 81	0 47	*	*	*	*	*	*
June	1 27	0 29	0 44	0 47	1 49	0 92	0 80	0 31	1 82	0 90	0 97	0 59	*	*	*	*	*	*
July	1 32	0 35	0 54	0 64	1 53	1 02	0 86	0 34	1 94	0 92	1 01	0 65	0 32	0 40	0 95	1 03	1 03	*
August	1 32	0 31	0 50	0 59	1 58	0 98	0 95	0 37	1 71	0 91	1 03	0 56	0 37	0 37	1 00	1 04	1 12	*
September	1 35	0 31	0 50	0 53	1 55	0 90	0 90	0 31	1 79	0 95	0 93	0 55	0 43	0 31	1 02	0 98	1 02	*
October	1 41	0 30	0 46	0 48	1 51	0 89	0 89	0 32	1 40	0 82	0 98	0 58	0 36	0 31	0 95	0 90	1 08	*
November	1 36	0 36	0 53	0 52	1 52	0 89	0 85	0 33	1 90	0 95	0 98	0 60	0 38	0 33	0 93	1 00	1 05	*
December	1 48	0 40	0 52	0 53	1 70	1 03	0 97	0 38	1 89	0 93	1 10	0 69	0 41	0 34	0 98	1 09	1 11	*
Annual Average	1 39	0 34	0 52	0 62	1 59	0 97	0 90	0 34	1 95	0 92	1 01	0 61	0 38	0 34	0 97	1 00	1 07	..
1950	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
January	1 75	0 40	0 61	0 60	1 93	1 21	1 15	0 41	1 98	*	1 25	0 77	0 42	0 49	1 15	1 20	1 27	0 44
February	1 72	0 37	0 56	0 53	1 82	1 22	1 03	0 36	2 26	*	1 14	0 74	0 37	0 46	1 15	1 21	1 21	0 39
March	1 82	0 44	0 59	0 71	1 89	1 18	1 08	0 38	2 05	*	1 16	0 75	0 38	0 49	1 15	1 21	1 23	0 41
April	1 89	0 39	0 55	0 58	1 76	1 09	1 04	0 35	1 95	*	1 09	0 73	0 35	0 44	1 06	1 13	1 17	0 38
May	1 94	0 36	0 57	0 59	1 74	1 03	1 07	0 35	1 99	*	1 13	0 75	0 35	0 44	1 01	1 14	1 13	0 34
June	1 86	0 39	0 62	0 60	1 80	1 12	1 12	0 38	2 08	*	1 24	0 79	0 38	0 45	1 11	1 20	1 24	0 38
July	2 06	0 42	0 66	0 62	1 85	1 16	1 18	0 44	2 04	*	1 28	0 82	0 44	0 49	1 14	1 24	1 29	0 42
August	1 98	0 42	0 63	0 64	1 84	1 18	1 15	0 37	2 16	*	1 23	0 77	0 50	0 45	1 18	1 24	1 27	0 38
September	2 11	0 44	0 65	0 68	1 87	1 17	1 17	0 34	2 34	1 18	1 24	0 79	0 52	0 42	1 19	1 26	1 30	0 40
October	2 18	0 46	0 67	0 72	1 97	1 23	1 19	0 39	2 30	1 22	1 26	0 82	0 50	0 47	1 21	1 33	1 35	0 40
November	2 48	0 51	0 75	0 83	2 42	1 50	1 37	0 49	2 45	1 36	1 60	0 93	0 59	0 55	1 41	1 53	1 64	0 48
December	2 36	0 51	0 77	0 82	2 52	1 52	1 40	0 50	2 23	1 30	1 64	0 95	0 57	0 59	1 39	1 53	1 64	0 58
Annual Average	2 01	0 43	0 64	0 66	1 95	1 22	1 16	0 40	2 15	1 27	1 27	0 80	0 45	0 48	1 18	1 27	1 31	0 42

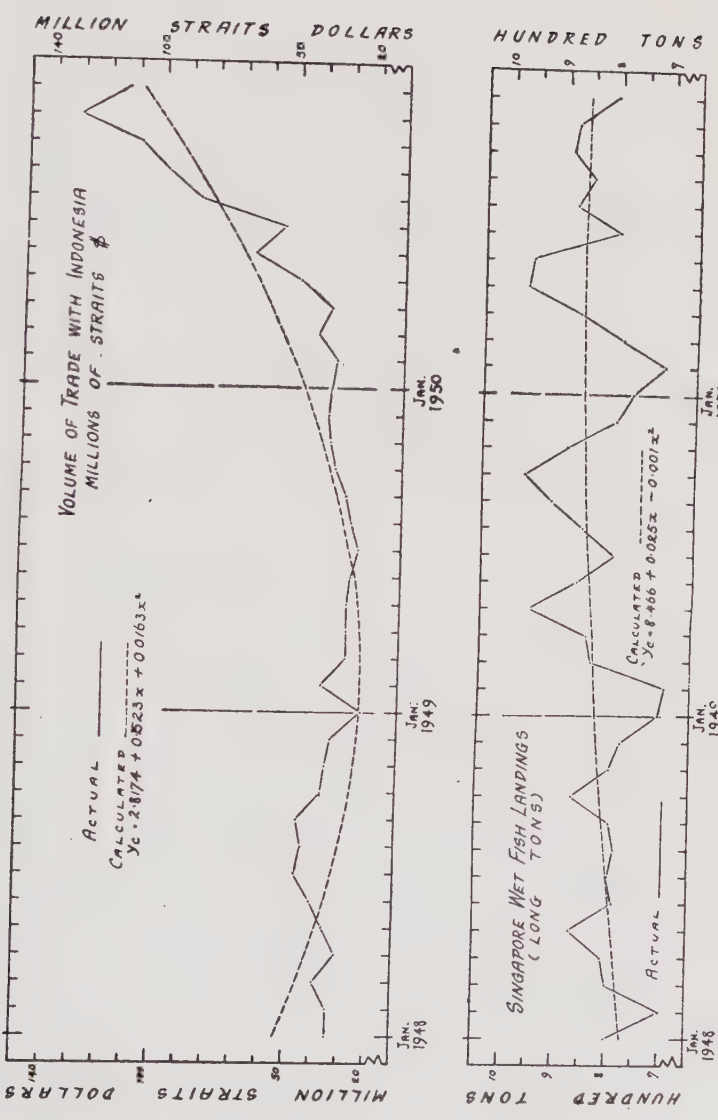
*No figures available.


PRICE ANALYSIS
MONTHLY AVERAGE DAILY RETAIL PRICE
FOR VARIOUS CATEGORIES OF FISH
(JAN.1948–DEC.1950)
ACTUAL
CALCULATED
KURAU FISH
y_c = 138·725 + 0·933 x + 0·129 x^2
1ST. QUALITY
y_c = 95·890 − 0·008 x + 0·129 x^2
2ND. QUALITY
y_c = 58·091 − 0·319 x + 0·080 x^2
3RD. QUALITY
y_c = 33·937 + 0·077 x + 0·036 x^2
Cents Per Katty
250
200
150
100
50
20
January 1948
January 1949
January 1950

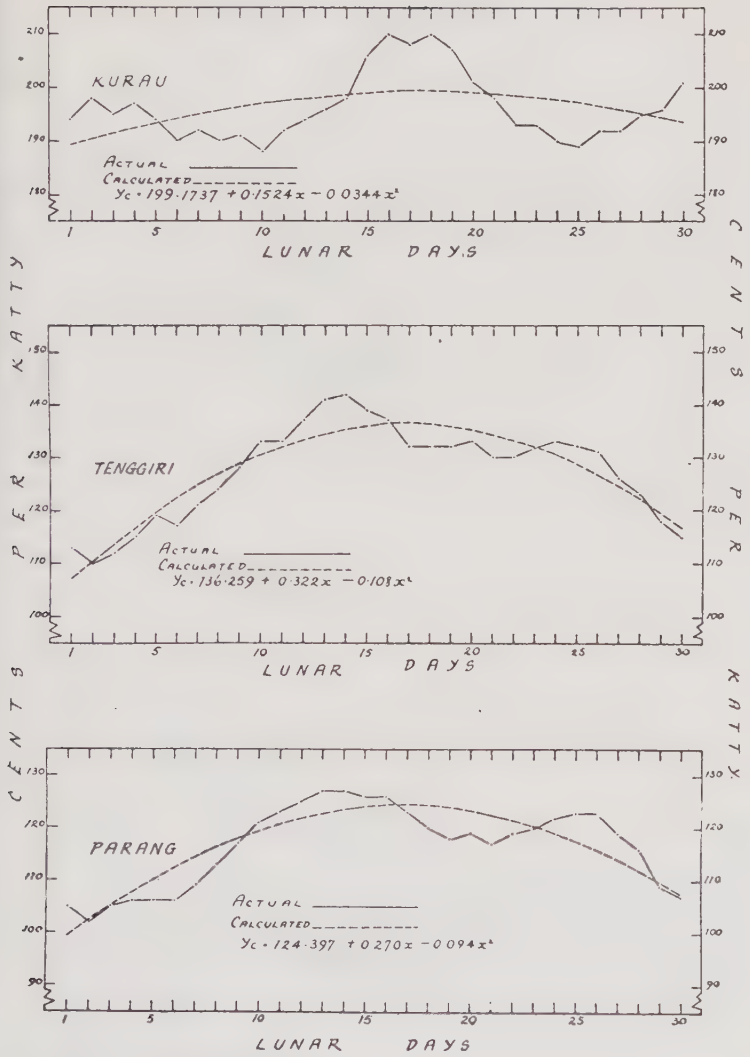
Graph 23A



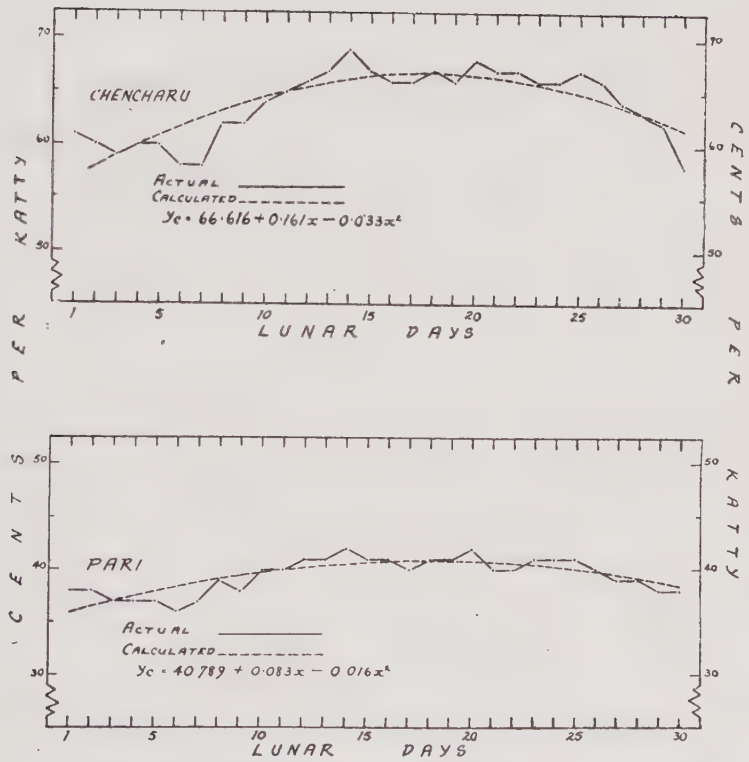
Graph 23B. Monthly Average Daily Price of Rubber (R.S.S. No. 1)


MILLION STRAITS DOLLARS
VOLUME OF TRADE WITH INDONESIA
MILLIONS OF STRAITS $
ACTUAL
CALCULATED
Yc = 2·8174 + 0·0523x + 0·0163x²
JAN. 1948
JAN. 1949
JAN. 1950
HUNDRED TONS
SINGAPORE WET FISH LANDINGS
(LONG TONS)
ACTUAL
CALCULATED
Yc = 8·466 + 0·025x − 0·001x²
JAN. 1948
JAN. 1949
JAN. 1950

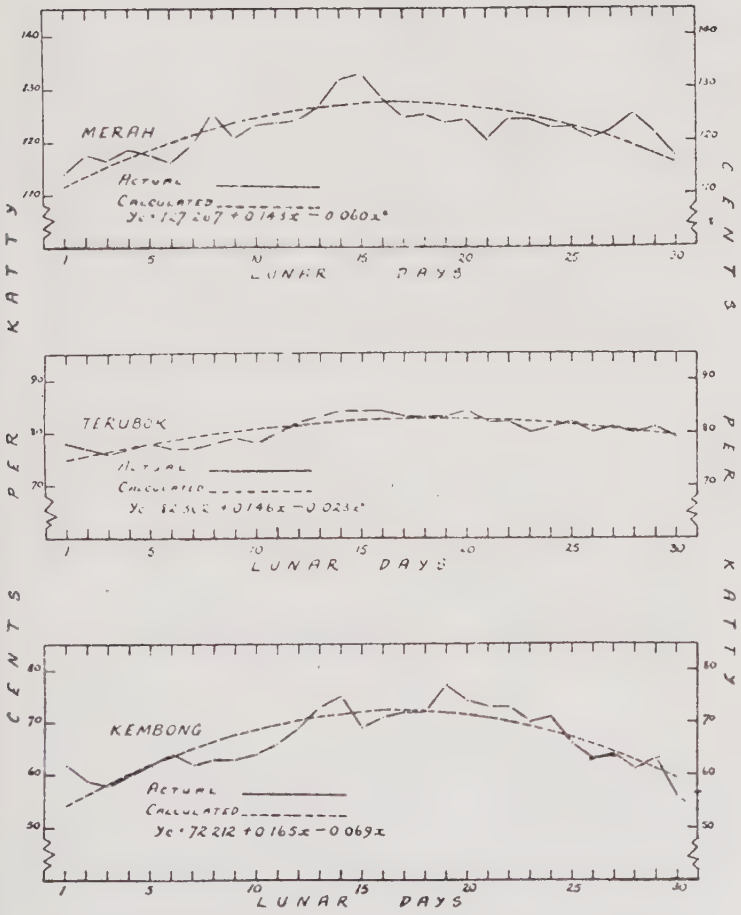
Graph 23c



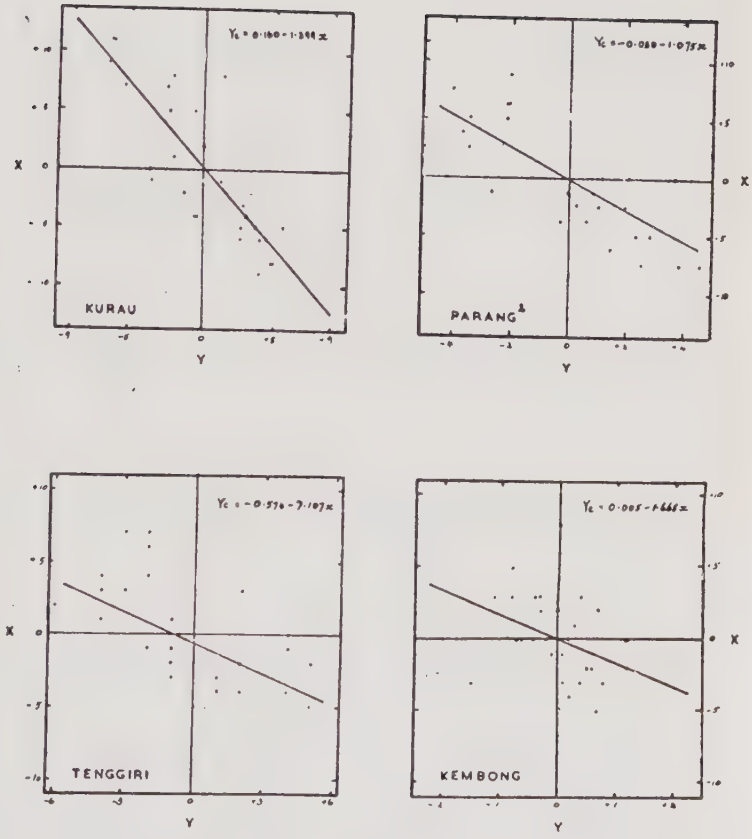
Graph 24. Lunar Mensal Average Daily Retail Price for the lunar year ending 5-2-51 (*Kurau, Tenggiri* and *Parang*)



Graph 25. Lunar Mensal Average Retail Price for the lunar year ending 5-2-51 (*Chencharu* and *Pari*)

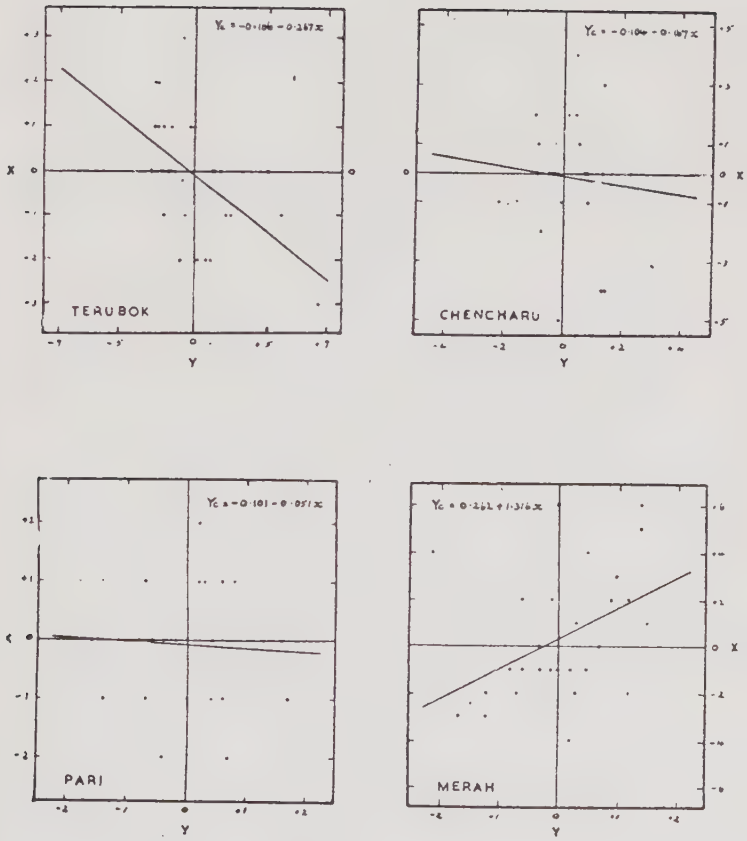


Graph 26. Lunar Mensal Average Daily Retail Price for the lunar year ending 5-2-51 (*Merah*, *Terubok* and *Kembong*)



X = Variation From Mean Landings In Thousand Katties.
Y = Variation From Mean Retail Price In Cents.

Graph 27. Relationship between Supply and Demand for certain types of fish during the lunar year ending 5-2-51



Graph 27—*continued*

5. DISCUSSION

5.1 PRELIMINARY INTERPRETATION OF THE RESULTS TO THE PRESENT STAGE

THE present report offers no final conclusions concerning the systems in respect of which statistics have been collected. Its main concern is with the statistical series which are available and with certain series which should be made available. It describes the existing series and analyses them to a preliminary level in order to test their value and to be able to propose, where necessary, measures for their overhaul and general improvement. In making this analysis it has been necessary to go through a rehearsal, as it were, of the full performance of statistical treatment which will be presented when the series have been made more satisfactory in the ways indicated. In the course of this rehearsal certain tentative conclusions have been drawn as to the systems to which the statistics relate; whatever value these conclusions may eventually prove to have, they serve at this stage as working hypotheses both in respect of the systems themselves and of the statistical methodology.

The systems are represented by figures 4, 5 and 6 jointly and the questions posed on page 5 may be resolved into the one proposition: are these systems adequate to meet the fish requirements of the Colony of Singapore, and if not, can they be made adequate? And since it is obvious that the systems are inadequate, the question further resolves to: what measures should be taken to develop these systems so that they should be made adequate?

The inadequacy of the present industry, and the seriousness of the problems may be judged from the following figures. In 1931 the fish supply amounted to 11,271.3 tons which, for a population of 557,745, gave about 45 lb. per head. In 1949 the supply amounted to 10,164.1 tons which, for a population of 980,818, gave about 23 lb. per head. Thus, the supply per capita has fallen practically to half, but the price has increased markedly. It is most probable that many factors contributed to the very considerable change in price, but among these the halving of supply (per capita), and the general depreciation of currencies over the past decade, are undoubtedly among the most important. Whatever these causes might be, the halving of the supply, and the rise in price undoubtedly constitute a situation certain to cause much dissatisfaction among the public, and the Colony's task is to restore the per capita supply to its previous level and take it beyond this and, if possible, to reduce the price.

The results obtained thus far in the analysis of the situation show not only the very great proportional dependence of the Colony on supplies drawn from beyond the limits of the Colony, and more particularly from non-Colony fisheries with their consequent dependence on political factors, but also the highly characteristic seasonal and lunar cycles which dominate the supply. It is fairly obvious that political factors are likely to control the general level of supplies until such time as the Colony's own industry develops to a level far beyond its present capacity. At the same time it is probable that the cycles at present observed are likely to continue to manifest themselves, and it may be accepted that in planning the market organization these changes in supply will continue and should be provided for. It is a matter for determination whether these cycles manifest themselves with equal energy in each of the lines of supply from which the supplies are drawn. It seems likely that along certain of the lines from which the volume of supply is steadily diminishing the fluctuations are also being damped and are losing their significance. On the other hand there is evidence that in some of the sources from which supplies might be newly

drawn, or brought in increased volume, the behaviour of the fish and the characteristics of the fishing operations are such that the lunar periodicity might be reduced in importance.

The magnitude of the seasonal and lunar effects is shown by the following table which presents, as the percentage departure from the average of each cycle, the weight of each month in the seasonal cycle and of each day in the lunar cycle.

Table XIV

MAGNITUDE OF SEASONAL AND LUNAR EFFECTS

1. Seasonal

Lunar Month	1	2	3	4	5	6	7	8	9	10	11	12
Percentage departure from cycle	−9.0	−1.5	6.0	6.8	1.5	−3.0	0	8.3	6.0	1.5	−4.5	−10.5

2. Lunar

Day of Lunar Month	1	2	3	4	5	6	7	8	9	10
Percentage departure from cycle	11.5	12.6	13.0	10.6	6.6	5.5	4.4	2.2	−0.2	−4.4
Day of Lunar Month ..	11	12	13	14	15	16	17	18	19	20
Percentage departure from cycle	−5.3	−6.6	−10.6	−10.2	−7.5	−8.6	−4.2	−4.0	−4.0	−4.9
Day of Lunar Month ..	21	22	23	24	25	26	27	28	29	30
Percentage departure from cycle	−2.9	−2.0	−0.9	0	−2.9	−2.6	−0.2	2.4	5.7	8.8

It may be pointed out that section 4.2, in indicating the trend of these statistics and the existence in them of seasonal and lunar cycles, presents, *albeit* tentatively, an answer to the first question posed in section 1.3. However, in noting this it is also to be emphasized that at least the seasonal and lunar cycles were already known, both to the industry and to the Department and that the importance of the present work is in confirming their existence, giving a quantitative expression of them, and indicating the correlations whose calculation may now be attempted.

Similarly, the study has added precision to existing estimates of the various components, geographic and specific, of the total supply and has indicated the type of variation to which these supplies are subjected. Since the work is relatively new, and the statistical series relatively short, the confidence which can be placed in the estimates of various parameters of these statistics must necessarily be limited; on the other hand the programme has not only laid a broad basis for the development of the work but has also indicated various lines along which improvements may be effected, notably in the collection of the statistics.

Among the geographic components the 'local supply', although generally less than 25 per cent of the total is, for this study, of great importance since it lends itself to much deeper study. As indicated above, a beginning has been made in the study of the relationship between the economic factors of production internal to the industry (amount and intensity of effort) and the production; and, as an independent study substantial and interesting results have been reported to have been obtained from correlations between production from selected fishing units and various biological and physico-chemical factors of the environment. These results indicate that from study of environmental factors fairly reliable predictions of supply patterns will be possible. It seems likely that with the development of this work, predictions as to level of production will be possible at least a couple of months in advance. Whatever length of period of prediction may become possible, it is clear that there will be available from this system a means of watching the supply at the markets and of applying what will in effect be virtually a kind of 'quality control' statistics, whereby significant departures from an established pattern of behaviour will be indicated as soon as they occur and will be capable of analysis and identification. It should be possible with this system to follow such deviations back to their root cause and this will permit either of administrative or technical action to cope with the deviating cause, or of appropriate adjustment of the remainder of the system to accommodate the change.

As opposed to these results which suggest the possibility of measures to ensure maintenance of the *status quo*, the analysis of local production should also give indications of measures which may lead either to improved production within existing limits or to increased production by the utilisation of new areas or methods or both.

The analysis of prices given in section 4.4 relates solely to post-war prices and takes no cognizance of pre-war prices, for the simple reason that no comprehensive statistics of pre-war prices are available. In point of fact, it must be accepted that much of the price statistics available for this study are of the second type mentioned at the beginning of section 4.4, namely, the 'quotation' or 'impression' type from which it would be unsound to attempt any estimate of total value of fish, other than within the very widest limits. Although an analysis of the statistics of this type has been made, and has given some interesting results, the need for a revision of the collection methods for price statistics has been recognized and a useful beginning has been made in analysing the factors which determine price. This analysis of factors has given already some measure of price variability in relation to critical factors and it should soon be possible, co-ordinating with the controlled statistics of production and supply, to draw close to realistic estimates of total transactions in the buying and selling of fish and to the measure of the financial operations taking place within the industry.

At the present stage the measurement of production costs has made little progress. There is a useful series of statistics of the costs of the materials from which the fishing gears are constructed and studies are proceeding to determine the quantities of these materials and of labour which is required for the construction of these gears. With the series of statistics of costs of these elements, it will be possible to formulate estimates of the gear-cost contribution to production costs. Such estimates will be related to the analysis of prices in the improved series and will lead to conclusions on the cost of elements (as distinct from profit) in production. Already some study has been made of the margins which arise in marketing and distributing the supply, but this will be of value only when the work on prices has been developed.

As indicated in section 4.4 the preliminary analysis has indicated certain major features of trend and fluctuation in prices. These, as might have been expected, vary from quality to quality of fish. The trends, over the period of record, are generally of a second degree and stronger in the higher priced fish than in the lower priced. Equally, the fluctuations in price are greater, proportionately as well as absolutely, in high-priced than in low-priced fish.

It will be seen from the foregoing that the survey has already obtained tentative answers to the questions posed in section 1.3 and in any case has laid down a system whereby the answers will be made more precise, and expressed quantitatively.

5.2 INDICATIONS FOR FUTURE PROGRAMME

The results obtained so far seem to warrant optimism as to the value of this work as a means toward furnishing the data required as a basis to planning the organization of the Singapore fishing industry. It has indicated in quantitative terms the importance of various factors operating in the industry and this would permit of the development of an organization which will effectively accommodate these factors. It has also indicated the lines along which the survey methods may be improved. Stated briefly the improvements will involve primarily the streamlining of the two types of statistical collection namely, the total enumeration and the sampling method. Certain elements must be totally enumerated with a fair degree of precision; these should include most of the factors of production and the supplies which pass through the most important markets. The remaining elements should be measured by sampling methods and it should be the practice to overhaul the sampling programme from time to time on the basis of results obtained. It is certain that much effort may be conserved by revision of the sampling programme so that where variability is great, attention will be proportionately more intense than where the material is homogeneous.

Beyond the improvements in the collection programme, the data will require development of the methods of analysis. It is obvious that much advantage will be drawn from a refinement of the treatment of the time-series and by the introduction of various correlation methods.

6. CONCLUSION

The only additional observation which ought to be made here by way of conclusion is that one of the principal results of this work has been to show the need for the development of careful statistical methods in examining the industry. There has been a great deal of rather loose criticism about the Singapore fish supply which it has been impossible to confirm or refute in the absence of measurement of the various factors which affect the system which is under discussion. This measurement has now been furnished, even if only tentatively, and a machinery has been brought into existence to develop the results to a better level of efficiency. The results obtained so far dispose of many misconceptions which have arisen and bring various factors and elements into their proper proportions.

Finally, the authors wish to acknowledge here the help they have had, by discussion and in other ways, from the Director of Fisheries; and the untiring efforts in the machine work of calculations given by William Tan and Stephen Chua.

Submitted to the Co-operative Fish Marketing Committee on 29th June, 1951

7. GLOSSARY

WEIGHTS AND MEASURES

The standard measures recognised by the laws of the Colony are as follows:—

standard of length, the imperial yard;
standard of weight, the imperial pound;
standard of capacity, the imperial gallon.

The following are the principal local measures used with their English equivalents:—

the tahil	1 1/3 oz.;
the kati or katty (16 tahils)	1 1/3 lb.;
the picul (100 katis or katties)	133 1/3 lb.;
the koyan (40 pikuls)	5,333 1/3 lb.

All weights expressed as tons refer to long tons (2,240 lb.) unless specified otherwise.

CURRENCY

The Straits dollar, which is the unit of currency used throughout the Report, equals 2s. 4d.
erling.

bbreviations.

$ = Straits dollars.
kts. = katties or katis.

verage: Adjectives of time qualifying the noun 'average' are used to express two distinct concepts depending upon their position in relation to this noun. The word which precedes the noun indicates the period in which the unit obervations were taken and averaged, whereas the word which follows it indicates the time interval to which the unit obervations relate. Thus Monthly Average Daily Landings means the average landings per day in each month; again, Annual Average Daily Landings means the average per day for the year. In order to strengthen this convention the following usage is suggested.

Period	Comparison within Unit Periods	Comparison between Unit Periods
ours	Horal	Hourly
ays	Diurnal	Daily
eeks	Hebdomadal	Weekly
onths	Mensa 1.	Monthly
ear	Annual or Seasonal ..	Yearly
our Years	Quadrennial	——

tch: The total weight of fish secured by capture operations.

ports: Imports relate to fish transported into the Colony from other territories and includes fish caught by Singapore licensed motor vessels in waters outside the territorial waters of the Colony (3 sea miles). This practice was accepted in the past and is incorporated in external trade statistics as the quantity concerned is small. Differentiation is now under consideration and a record of extra-territorial production by Singapore vessels has been separately maintained by the Fisheries Department, Singapore, with effect from 1-1-51.

Industrial Supply: The total quantity of fish, including processed edible fishery products which passes through trade channels. It excludes quantities produced for subsistence consumption.

Market Handlings: The total quantity of wet fish recorded as passing through the auction markets of the Colony.

Lunar Month: The lunar month utilised throughout this report refers to the Chinese Lunar Month which is already familiar to the fishermen of this Colony. In the Chinese Lunar Calendar the first day of each month is fixed as the fifteenth day preceding the day of the full moon. The months are, therefore, of 29 or 30 days in duration. This Calendar has the advantage that, although based on lunations, it is adjusted to the solar cycle by the inclusion of a double or inter-calary month at intervals of 3 or 2 years, there being 7 inter-calary months in 19 years as a general rule. These months are so arranged to bring the position of certain Chinese Lunar festivals into a more or less fixed position vis-à-vis the solar cycle. For example, *Tang Choik*, which is observed in the 10th moon, falls on the 22nd December except for rare occasions when it may vary by one day, and *Cheng Meng* (Chinese All Souls Day) which is observed at either the end of the 2nd or beginning of the 3rd lunar month invariably falls on the 5th April.

For the purposes of calculations, adjustment for the inter-calary month has been made by taking the mean of the double months. (It is necessary to remember that the Chinese Lunar Year does not, however, correspond with the solar year and that the period of observations for the consideration of the data by lunar periods was 22nd January, 1947—5th February, 1951 unless otherwise stated).

Prices: *First Wholesale Price*—The First Wholesale Price relates to the actual price received by the fisherman.

Last Wholesale Price—The Last Wholesale Price relates to that received by those fishermen, collectors or agents who sell their fish through a licensed wholesale agent (in the Municipal Markets) or auction operatives (in Private Markets) in one of the auction markets. This price, less market levies and the commission charged by the auction operative is identical with the Auction Price. Occasionally additional services, such as transport and re-icing for storage are provided and for these further deductions may be made.

Auction Price—The Auction Price is the price at which the fish is auctioned.

Retail Price—The Retail Price is the price paid by the consumer. In this Colony the retailer may sell small quantities of fish to itinerant hawkers for resale to consumers, but the price paid by the hawker is similar in level to the retail price although a percentage commission is allowed by the seller. These hawkers subsequently make direct sales to the consumer and the price paid at such transactions is referred to as the 'Second Retail Price'. Thus the hawker virtually acts as agent for the consumer, who is thus able to make purchases without the inconvenience of visiting the market.

Subsistence Consumption: This term refers to the consumption of fish caught for the domestic use of the operator himself or his family. Such fish does not enter the marketing system whether the operator is a professional fisherman or not. The term is derived from subsistence fishing i.e. fishing operations which are solely undertaken to provide fish for the operator or his family. In this Colony this is widespread and, as such operations are exempt from licensing regulations, it is difficult to assess the level of such landings.

Total Real Consumption: The total quantity of fish which is consumed by the population during a specified period of time. It can be expressed simply as follows:—

(Imports + Production) — (Exports + Total Wastage) = Total Real Consumption.

Holdings in stores are negligible in quantity and, therefore, for the purpose of this survey are neglected.

Wet Fish: Fresh fish, or fish in ice, which has not been subjected to any form of processing.

MALAYAN NAMES OF FISHING GEAR

Ambai	Static gape net
Belat	Intertidal fishing stake
Belat bubu	Inshore fishing stake
Bintur	Crab lift net
Bubu	Portable Fish-pot
Chandat	Cuttlefish jig
Empang	Set-barrier
Jala	Cast net
Jaring hanyut	*Tenggiri-parang* drift net
Jaring selangat (Chinese)	Drive-in sunken gill-net
Joran	Rod and line
Kelong, kelong kuwat, kelong bilis	Offshore palisade traps
Moro-ami	Japanese drive-in net
Panching	Hand-line
Panching tunda	Troll-line
Pelontang	Floated single line
Pukat payang	Sunken boat seine
Pukat tarek	Beach seine
Rawei umpan	Long line
Sauk	Dip net
Sondong	Prawn push net
Tangkul	Frame lift net

MALAYAN NAMES OF FISHES

Malay Name	*Scientific Name*
Bilis	*Stolephorus* spp.
Chencharu	*Megalaspis cordyla* (Linnaeus)
Daing blang	*Caranx* spp.
Deham	*Teuthis* spp.
Delah	*Caesio* spp.
Ikan champor	Mixed fish
Kekek	*Leiognathus* spp.
Kembong	*Rastrelliger* spp.
Kerapu	*Serranus* spp.
Kurau	*Polynemus* spp.
Merah	*Lutianus* spp.
Parang	*Chirocentrus dorab* (Forskael)
Pari	Rays
Selar	*Caranx* spp.
Selar kuning	*Caranx leptolepis* (Valenciennes)
Sotong	*Loligo* spp.
Tamban	*Clupea* (*Harengula*) spp.
Tenggiri	*Scomberomorus commersonii* (Lacepede)
Terubok	*Hilsa* spp.
Tongkol	*Euthynnus* spp.
Udang	Prawns
Yu	Sharks

N.B.—In Malay the word *ikan* meaning fish always precedes the specific name. For simplicity this has been omitted in this report.

8. APPENDICES

APPENDIX I

LICENCE FORMS

A. Fishing Boat

Fisheries 5 Serial No.

MERCHANT SHIPPING ORDINANCE
(CHAPTER 150)

(Ss. 442 and 447)

LICENCE OF FISHING BOAT

(Space for photograph)

Registered No. .....
Name of Owner/Licensee and Residence.....
.....
.....
.....

Master's or Headman's Name and Residence
.....
.....
.....

No. of Crew.....Fishermen....Total.....
Description of Boat .....
and Dimensions .....

Methods of Fishing:—
(*a*) Principal.....
(*b*) Subsidiary .....

Fish Storage Facilities.....
Base.....
Area of Operation.....
Date of Licensing.....
Amount of Fee paid 50 cts.

Licensing Authority

Names of Crew and Fishermen:—
.....
.....
.....

Name of Agent through whom fish is normally disposed.....
.....
.....
.....

(Face) (Reverse)

Fisheries 3
No.

FISHING LICENCE

Issued under the Fisheries Ordinance (Chapter 146)

Name of Licensee.....

Place of Residence.....

No. in Register.....

Method of Fishing.....

No. of Assistants.....

Date of Registration.....

Date of Issue.....

Date of Expiry 31st December.....

Number of Boat Licence.....

Amount of Fee*.....

Fishery Officer.

---

*The licence fee varies from 50 cts. to $20 for different types of gears.

APPENDIX II

A PRELIMINARY NOTE ON THE USE OF SAMPLING METHODS IN ESTIMATING PRODUCTION

Although estimates have been made of local production, as indicated in the text and in tables, there rest important questions as to the reliability of the results, both those made so far and those which may be made later by the same methods, and as to the efficiency and economy of the methods in use.

For reasons given in the text it is impossible to obtain complete record of local fishing operations and their production, and the programme at present in operation may best be described as a mixed one; that is to say, the present system takes whatever proportion of record may be possible and does not rely on a logically rigorous system of sampling. It is possible that the present programme is sufficient for the requirements of any administrative and developmental programmes which might be formulated in relation to this industry—but the possibility may not be ruled out that the programme might be found to be inadequate, or in any case that efficiency might be increased and economies effected without any grave difficulty.

The argument of this estimate involves the following sets of data:—

(1) Complete enumeration of one or more of the factors of production available for use.

(2) Reliable estimates, from selected units of the enumerated factor, of the operations (amount of use) of these factors.

(3) Reliable record in respect of the same units of the result of these operations.

From these sets of data there can be drawn, by appropriate proportionality calculations, an estimate of the total production which the full complement of equipment achieved. These calculations involve the use of various weights appropriate to the numerical strength, the fishing efficiency, etc., of each of the different types of unit of the totally enumerated factor. The methodology is well advanced as described in such works as those by *Yates* (1949) and *Deming* (1950). In the present instance the problem is one of application of such methods to the particular problems of this industry, or a regional section thereof, and involves identification of the source of variance and the design of an efficient programme of sampling. The results of the work to date are inadequate to furnish a complete answer to these questions, but an indication can be given of the directions in which the results point.

It should be noted that the use of sampling methods in this work is now being tested in various places in this region, more especially in India where Panse and Sukhatme have recently published an account (not yet seen by the present authors) of a sampling programme which is, we understand, entirely random in its choice of units and makes no use of any frame composed of fishing units.

Factors of Production—These are discussed in the text, and the most recent information in respect of them is contained in the Tables II to V. In 1950 there were 1,239 licensed units of gear consisting of twenty-one different types; of these various types, the *jaring hanyut* was numerically greatest, closely followed by the *kelong*, the prawn pond net and the *bubu*. The relative numbers of these are of some importance to the present study. An account of the construction and operation of these units will be given in a subsequent report.

Operation of the Factors of Production.—At the present stage no direct record is kept of the amount of effort expended in the different fishing operations, and the operation of the gears is represented, in fact, by the number of units of catch reported. That is to say, if the record for a particular fishing unit shows a catch, say, 20 of the 30 days in the month, it is taken that the unit has been operated on only 20 days, and each of those 20 days is accounted as of equal value as amount of effort. Whilst it is probable that these assumptions are correct for certain types of gear, it is equally probable that such assumptions in respect of other types of gear will leave in the data a fairly considerable amount of variance which under better developed systems could be adjusted.

This point may well be clarified a little further. A *kelong*, which is a fixed palisade trap, will fish under certain tidal conditions as long as the lift net, by which the fish are removed from the enclosure, is operated by the crew. In general the crew will operate the net at regular intervals during the appropriate fishing hours if fish are present in the trap, and a catch of some size will be taken. In the present state of our knowledge we cannot say whether the frequency or mode of operation of the net exercises any influence on the amount of catch taken but, on the contrary, it is our impression that the net-operation has no significant influence provided it is operated at regular intervals; this means that the amount of fish caught is determined by the factors which bring the fish into the trap and hold them there. Therefore, if the net is operated and a catch is taken, the catch which results does represent the availability of fish to that unit. And since we assume that some catch, however small, will be taken if the net is operated, we feel safe in assuming that a nil record means no operation, and this means that the variance of the catch is produced by the factors determining the presence of the fish in the trap. Consequently it is our belief that we are not neglecting a source of variance in assuming

(*a*) that nil records mean nil operation, (*b*) that such variations as may occur in the frequency and mode of operation of the net, within certain limits, contribute little to the variance of the catch in this type of gear.

However, for other types of gear it is quite certain that the mode of operation and the frequency or duration of operation do determine the amount of catch; the relative abundance of fish on a particular occasion, of course, determines the amount of catch possible per unit operation, and the frequency and/or duration of usage in unit period combine with abundance to determine the total for the unit period. Moreover there is generally an interaction between the abundance and the operation. Furthermore, operatives vary in enthusiasm and efficiency. Thus for such types of gear the amount of catch per unit period, is determined by (1) abundance, (2) frequency and/or duration of operation, (3) efficiency of operation. In a complete analysis for such gears an independent measure of abundance would be sought, record would be kept of the frequency and or duration of operation, and some index of efficiency of operation would be sought. In the present analysis, however, we must allow the variance from these three to remain lumped together. These problems have, of course, been discussed at great length in scientific literature on fisheries.

We have had to assume for all gear types that nil returns indicate no fishing operation, and that each return (or day's catch) signifies the catch from operations of frequency and/or duration characteristic for the operation of that gear in these waters. It must be recognised that these assumptions mean that the averages calculated in this work should not be thought of as catch-per-unit effort, but as catch-per-man-day or of other such unit which must be accepted as including differences of amount of effort expended as well as differences of yield per unit effort. The first assumption has recently been verified by a modification of the existing system in which nil returns are differentiated into returns showing 'no operation' or 'operations and no catch'. Preliminary results show that, except for the *pukat payang* in which the fish are located before the net is set, the assumption is sound and in the latter case returns now distinguish between days upon which the unit went to sea and those on which it did not.

Preliminary Estimate—It is generally understood that the *kelongs* are responsible for a large proportion of the Singapore local production—perhaps as much as 70 per cent. If this should prove to be true then the average catch per unit of gear over all other types of gear would be relatively small, in fact 0.775 tons per unit. If any of the remaining types should be exceptionally efficient, then the average for some gears would be very small. These possibilities, related to the relative numbers of the different types of gear, point to some important aspects of the plan of the sampling programme. Using the estimates at present available we are able to construct the following table:—

Table A

Type of Gear	Number of units	Estimated average catch per month	Estimated average catch per year	Estimated Total per year	
		Katties	Katties	Katties	Tons
Jaring hanyut	255	335	4,020	1,025,100	610.2
Kelong	248	1,639	19,668	4,877,664	2,903.4
Bubu	123	161	1,932	237,636	141.5
Pukat tarek	77	1,200	14,400	1,108,800	660.0
				7,249,200	4,315.1

This table suggests that either the mean values are too high, being drawn from data relating to units whose catch is better than average, or that the figure for the market handlings of local origin shown in Table I of this Report represents only much less than 75 per cent of the total local production since the total of over 7 million katties (approximately 4,300 tons) in the above table is for only four gear types numbering 703 units; the remaining 536 licensed gears would produce a further about 270 tons if their average fishing success were only as great as that of the *bubu*. In addition there were about 1,050 unlicensed units of gear contributing to the total of local production. Neglecting the catch of the unlicensed gear, our calculations indicate a local production in the order of 4,600 tons as against market handlings of local production of about 3,100 tons, requiring a downward adjustment of our estimates by one-third, or the discovery of the avenues through which disposal takes place of this proportion of the catch. However, it must be emphasized that these are only trial, first-stage calculations which are not thought

to indicate actual conditions with any precision, particularly as there is often a strong seasonal feature in both the usage and productivity of fishing gear which, of course, is not allowed for in the above calculations.

However, the above table has one other interesting feature in that it supports the view mentioned earlier that the catch of the *kelongs* is in the order of 65 to 70 per cent—in the above table it is 67.3 per cent, and in the full total the *kelong* catch would be 63 per cent. This might be internal evidence of the validity of this table.

THE ESTIMATE OF CATCH FROM DIFFERENT GEAR TYPES

1. *KELONG*

Records were taken from the operation of representative units from each of the different localities (of which there are in all nine) identified by position in relation to the island, and by depth of water—either less or more than 3 fathoms of depth at low water spring tides. An effort was made to obtain records from three units in each locality but this proved impossible in respect of two localities for which only two units and one unit respectively were available: in addition, the records of two units of one locality were excluded from the analysis because of gross incompleteness of the record. In the final analysis there were records for three months from 22 units. These records are daily records of catch for 89 days (the months are Chinese Lunar months of thirty days, except the second month which had only 29 days); there was no record for various units for a total of 10 days, leaving the total number of recorded catches as 1948. For the ease of calculation the gaps in the records, including the thirtieth-day of the second month, were filled by entering the catch of the preceding day. Fortunately this did not involve the repetition of any of the extreme catches.

The mean daily catch of all units for the entire period is 54.62 katties but this is the mean of a considerable variation, from 2 to 3,072. The nature of the variability can be seen from the following table of means.

Table B

MONTHLY MEAN DAILY CATCH OF VARIOUS UNITS (*KELONGS*)

Unit		MONTH i	MONTH ii	MONTH iii	Unit Mean	Situation Mean	Locality Mean	Grand Mean
I. E. S.	(1) ..	75.5	40.7	38.9	51.37			
	(2) ..	20.9	48.8	42.2	37.30			
	(3) ..	44.1	54.8	34.6	44.17	45.47		
I. E. D.	(1) ..	43.3	36.0	46.2	41.83			
	(2) ..	225.9	181.3	275.6	227.60			
	(3) ..	172.9	151.0	..	123.00	130.90	87.630	
II. E. S.	..	33.0	25.7	10.2	22.85	22.85		
II. E. D.	(1) ..	115.8	93.8	196.8	135.47			
	(2) ..	58.0	41.3	31.6	43.63			
	(3) ..	60.2	37.7	45.1	47.68	75.59	62.405	
I. N. S.	(1) ..	18.2	18.3	17.0	17.84			
	(2) ..	25.5	35.4	71.9	44.37			
	(3) ..	16.3	26.3	31.3	24 64	28.91	28.91	
II. N.S.	..	18.9	17.6	14.5	17.02	17.02		
II. N.D.	(1) ..	14.6	14.3	12.3	13.73			
	(2) ..	23.6	21.9	22.3	22.66	18.20	17.804	
II. W. D.	(1) ..	165.5	96.5	115.3	125.77			
	(2) ..	66.6	61.2	51.3	60.00			
	(3) ..	27.8	19.4	25.0	24.13	69.97	69.97	
I. W. D.	(1) ..	15.8	12.5	29.9	19.43			
	(2) ..	19.8	13.6	28.3	20.58			
	(3) ..	45.4	24.1	39.1	36.23	25.41	25.41	54.62
Month Means		59.427,	48.720,	55.694				

The Roman figures and the letters E, N, and W signify geographical position; the letters S and D signify water depth. That is:—

I. E.	.. East Coast Road (Tanjong Rhu to Eastern entrance to the Straits of Johore).
II. E.	.. Eastern entrance to the Johore Straits (Eastern entrance of Johore Straits to Ponggol).
I. and II. N. ..	.. Johore Straits excluding II. E., and sub-divided into:—
	I. North—Eastern Johore Straits (Ponggol to the Causeway).
	II. North—Western Johore Straits.
I. W.	.. West Coast Road (Pasir Panjang to Ayer Merlimau Group).
II. W.	.. Tuas and Sultan Shoal area.

S = Shallow (Constructed in 3 fathoms or less).

D = Deep (Constructed in over 3 fathoms).

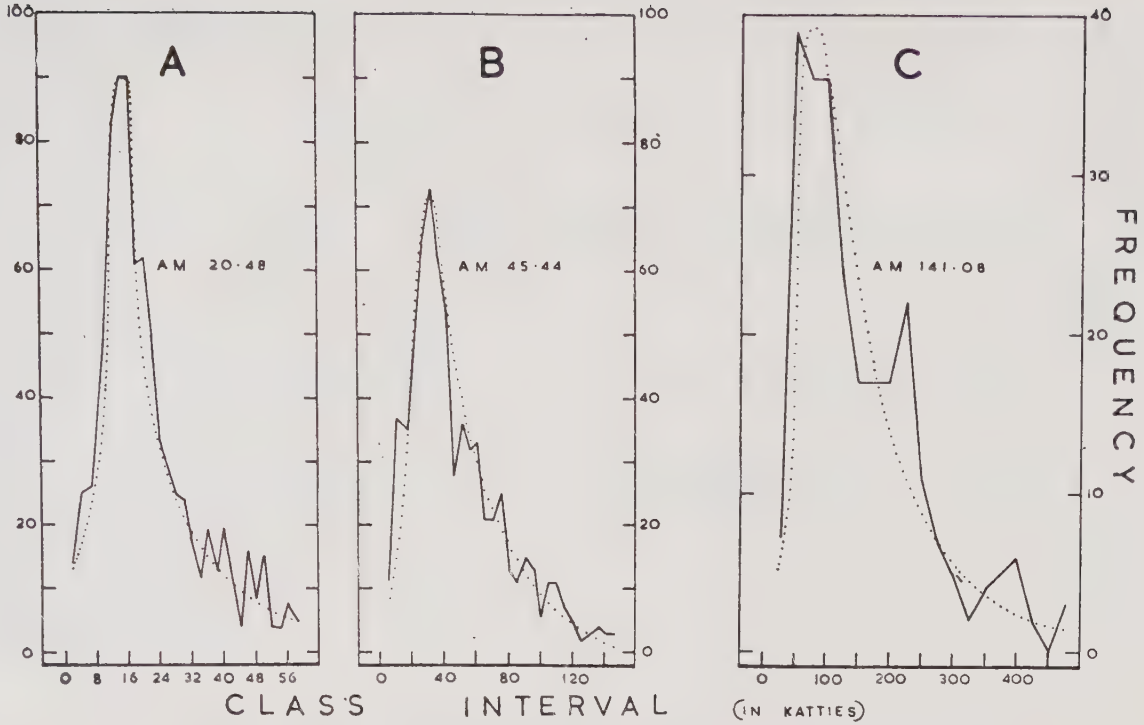
The range is of course reduced in this table, extending from 10.2 to 275.6. It will be seen that, although there are exceptions, the differences between months for each unit are relatively small, and over all units the monthly means are very close together. On the other hand the differences between unit means are relatively great and the differences between situation and locality means, whilst naturally progressively less, are still considerable compared with the differences between months. The situation means are the differences between units in the same locality but in water of different depth; now, whilst in general, and in respect of over-all average, the units at deep situations (more than 3 fathoms) seem to have caught more than those at shallow locations, this is by no means a clear conclusion from this table and the decision is rendered difficult by the fairly obvious importance of the locality differences. Also, it might be true that the eastern localities have better catches than the western or northern sections, but one would hesitate to say that Table II indicated this conclusively. Considering the comparison between situations at the same locality, in two instances where a comparison can be made the difference is great whilst in one it is small. But as against this we find that the differences between units at the same situation are as great as the differences between localities. Thus, in locality I.E. the situation means range from 37.30 to 227.60 and in II.E. the range is from 22.85 to 135.47. This table is not intended to present any final evidence on the levels of catch by units, situations, localities and months, but it does give a preliminary indication of the type of material to be handled. Thus, inspection of this table, and of the data from which it was drawn, suggests that the data might usefully be grouped into strata of the following dimensions:—

A A. from 0 to 25 katties per day, as average;

B B. from 26 to 100 katties per day, as average;

C C. more than 100 katties per day, as average;

It was decided that as a preliminary approach to an analysis of variance of these data, frequency distributions should be prepared of the original data, taken under the above classification in respect of the mean daily catch over the three months for each unit. The units were, therefore, consigned to one or other of these classes depending on the average daily catch of each over the period, and a frequency distribution of the daily catches within each category was then prepared. These distributions are shown in Table C and Figure 28 and it will be seen that the curves are very similar in shape and main properties; thus the ratios of mean to range are 2.83, 3.19 and 3.37: whether extension of the records would bring these ratios closer, and make the curves even more closely similar, will be determined by later work. It probably follows from these properties of the curves and from the arbitrary grouping, that the ratios of mean of group B to mean of group A, and of mean of group C to mean of group B, should be fairly close and that a similar situation should exist in respect of the relationship of the ranges of these distributions.



Graph 28. Frequency Distribution of Catch of *Kelongs*, Stratified by Average Catch.

Table C

FREQUENCY DISTRIBUTION OF DAILY CATCHES OF *KELONGS*

Stratum I (0–25 katties)		Stratum II (26–100 katties)		Stratum III (More than 100 katties)	
Class Interval	Frequency	Class Interval	Frequency	Class Interval	Frequency
0– 2	14	0– 5	11	0– 25	9
3– 4	25	6– 10	37	26– 50	39
5– 6	26	11– 15	35	51– 75	36
7– 8	31	16– 20	55	76–100	36
9–10	49	21– 25	64	101 125	24
11–12	79	26– 30	73	126–150	17
13–14	90	31– 35	62	151–175	17
15–16	90	36– 40	53	176–200	17
17 18	61	41– 45	28	201–225	22
19–20	62	46– 50	36	226–250	11
21–22	50	51– 55	32	251–275	7
23–24	33	56– 60	33	276–300	5
25–26	29	61– 65	21	301–325	2
27–28	25	66– 70	21	326–350	4
29–30	24	71– 75	25	351–375	5
31–32	16	76– 80	13	376–400	6
33–34	12	81– 85	11	401–425	2
35–36	19	86– 90	15	426–450	..
37–38	13	91– 95	13	451–475	3
39–40	19	96–100	5		
41–42	12	101–105	11		
43–44	4	106–110	11		
45–46	16	111–115	7		
47–48	8	116–120	5		
49–50	15	121–125	2		
51–52	4	126–130	3		
53–54	4	131–135	4		
55–56	8	136–140	3		
57–58	5	141–145	3		
N	843		692		262
A.M.	20.48		45.44		141.08
Range / A.M.	$\frac{58}{20.48} = 2.83$		$\frac{145}{45.44} = 3.19$		$\frac{475}{141.08} = 3.37$
	$\frac{A.M._n}{A.M._{n-1}}$		$\frac{45.44}{20.48} = 2.22$		$\frac{141.08}{45.44} = 3.10$
	$\frac{Range_n}{Range_{n-1}}$		$\frac{145}{58} = 2.50$		$\frac{475}{145} = 3.27$

N.B.:—The above arrays do not include certain very extreme records which lay beyond limits given above.

Whilst it is early to attempt to reach any conclusion about the full significance of these ves we believe that they may be treated as random distributions, characteristic of a variable ich theoretically ranges from O to infinity, but which takes a characteristic mean value ermined by the construction, operation and location of the gear. It is to be noted that this ve is often met in such work as this; it has been met by the senior author under a number circumstances. In the present study similar curves have been obtained for both the *jaring ayut* and the *pukat tarek*. It seems to us that this type of curve suggests that the size and nstruction of the gear, and the fishermen's regime of operations are adjusted to an expected

average level of abundance which exists on the majority of days, and that whilst the majority of the catches are of this level, other catches beyond the range (and necessarily only greater) occur in accordance with erratic movement of the fish. It further seems that such a curve would be more characteristic of a stationery gear than of a moving one and more characteristic of gears in the littoral than of those further from the shore, since in both these cases there is imposed a significant restraint. It suggests, therefore, that a proper analysis of this curve would probably yield useful results.

For the present study we assume that the curve indicates a characteristic result of the random operation of the factors determining the catches and whilst the question of transformation of the data must still be investigated (logarithmic transformation is clearly indicated), we venture to proceed with the analysis of variance of these data untransformed. This argument holds for the other types of gear.

The first analysis, for main effects—localities, depths and months,—is set out below. It will be seen that differences between sites account for the bulk of the variance in this set of data and that the other effects are of no significance. The remainder, which is relatively small, includes day effects, and also first and second order interaction. These other effects should, of course, be measured but in view of the very considerable magnitude of the situations effect, and of the great amount of calculation involved, it is thought that these minor effects ought to be considered in analyses made separately for each situation. One of these analyses has been made, for the situation I.E. at more than three fathoms, and the results are shown in the following tables.

Table D

ANALYSIS OF VARIANCE FOR MAIN EFFECTS OF DAILY CATCH BY 22 *KELONGS*

	df	*M.S.*	
Localities	5	289,731	
Depths	1	555,615	
Months	2	19,423	AM = 54.62 katties per day.
Days	29	9,859	
Remainder ..	1,942	9,680	
Total ..	1,979	710,671	

$\sigma = 103.3$, $\frac{\sigma}{\sqrt{n}} = 2.3$, C.V. = 4.2 per cent.

This analysis shows significant mean squares for localities and depths, and non-significant mean squares for months and days, and consistent with the latter result is the small amount of mean square for the days by months interaction (Not shown in the analysis here). From the total variance the coefficient of variation is 189 per cent, that is, the standard deviation of the mean is almost twice the mean. However, the standard error is roughly 4.2 per cent of the mean, and the mean can be said to have lain between about 50 and 59 katties per day, at 5 per cent fiducial limits.

Table E

ANALYSIS (INCOMPLETE) OF VARIANCE OF DAILY CATCH BY 3 *KELONGS* AT ONE LOCALITY IN ONE DEPTH

	df	*M.S.*	
Sites	2	225,279	
Months	2	18,123	
Days	29	13,183	
SXM	4	137,978	AM = 130.90 katties per day.
SXD	58	26,542	
Remainder ..	174	11,764	
Total ..	269	18,793	

$\sigma = 137.08$, $\frac{\sigma}{\sqrt{n}} = 8.36$, C.V. = 6.4 per cent.

The analysis in respect of a single locality (Table E) shows again the overwhelming importance of the situation effect, which carries over into the first order interaction of situation with days and also with months, but the months and days effects are not significant, nor is the month by day interaction, nor the second order interaction. On the total variance, using the standard deviation, the coefficient of variation of these data is much reduced: about 105 per cent whilst the standard error is 6.4 per cent of the mean, giving an estimate of the mean as

lying, at 5 per cent fiducial limits, between 114.5 and 147.3 katties per day. The slightly increased coefficient of variation calculated from the standard error, is due to the fact that the analysis is made of a much smaller series with much more abrupt differences between the principal components of the set.

Using the established arguments, based on the inversion of the formula for t, the above results indicate that reliable estimates of mean catch could be obtained from similar material with the use of much smaller samples: in fact, for locality I.E. a sample of 11 is indicated. However, because of difficulties of interpretation of the results of the analysis we hesitate to use this particular result just as it stands and instead we adopt a different line of argument. It is to be noted that the system of collection is such that choice of data exists as between situations and localities and units, but not between months and days; that is to say, the record for each unit will generally be complete and to attempt to omit any months, or any days, would involve complications which make such a procedure impracticable. Therefore the question is how many units, at how many situations, or localities, must be recorded to enable us to place any reliance on the estimate which we make from the sample. For this purpose we are convinced, from the above consideration of frequency distributions by strata, and from our examination of the raw data and of the above analyses of variance, that the most important consideration is the individual situation of each unit, rather than the locality or the depth. It is true that the table of means given above, and the analyses of variance, show that some localities gave bigger catches, in the period, than others, and that the catches in water of more than 3 fathom depth were greater than those in water of less than 3 fathoms. Nevertheless, the differences between these means are not consistently distributed, so that each situation and each depth includes representatives of the different strata. We, therefore, incline to the conclusion that the factors which determine the principal level of catch (and therefore stratum) are more important than either locality or depth and are possibly combinations of these and other effects. On the basis of these arguments, therefore, we have made an analysis of variance of the monthly means of units grouped in the strata described above. The results of these analyses are shown in the accompanying table which indicates the coefficients of variation of these means and the number of units (=situations) which must be sampled at each to give a reliable estimate of the monthly mean daily catch from each stratum.

Table F

PARAMETERS OF DAILY CATCH OF VARIOUS *KELONGS* GROUPED INTO STRATA

Stratum No.	Katties per day	A.M.	σ	$\frac{\sigma}{\sqrt{n}}$	CV. (per cent)	n*
I	26	20.307	6.32	1.23	6.05	16
II	26–100	45.196	13.83	2.66	5.80	9
III	100	153.040	63.62	19.18	12.53	26

We take the results given in Table F to mean that in dealing with units taking catches comparable (in size and distribution) to those of these three strata we would require at least 16, 9, and 26 such means, respectively, to obtain results of a similar level of reliability, and since these means relate to a three-month interval, we take it that the results from about 5, 3, and 9 units regularly recorded over a similar period would give us similar results. We would also assume that this would continue to hold over a longer period, with some reservations in respect of the possibility that the seasonal variations noted in the body of the paper might mean changes of variance within the strata in addition to the changes in amount of catch. For this last reason we would consider it advisable to work with larger samples than are indicated in Table F; this increase in sample size must be done arbitrarily to begin with, and it may be found that simply by doubling the above numbers we shall have a workable and reliable programme. However, at the earliest opportunity an effort will be made to form an estimate of the numbers of these units which fall into each of our strata and these numbers will be weighted by the estimates of variance contained in Table F, or by some subsequent improvement of them, to furnish a basis for a sampling allocation for continued work.

It may also be noted that these results suggest a mixed system of estimate which would make use of the fact that whilst an operative may be unwilling to keep full detailed records of catch, or even an accurate record of his total catch for an extended period, he might be willing to give sufficient information to indicate the group, in the above system, to which his catches belonged. Therefore, although a preliminary survey might assign units to these categories, adjustment of such 'assigned' totals might be made on the basis of the rough reporting.

*For 5 per cent level of accuracy.

2. *PUKAT TAREK*

The records were taken of three units at each of two localities over a three month period. The records are fairly complete although there are days of nil-return. The mean catch, for locality, month, and unit, is shown in the following table.

Table G

MEAN DAILY CATCH TAKEN BY SIX *PUKAT TAREK* UNITS DURING A THREE MONTH PERIOD, OPERATING IN TWO LOCALITIES

Month	LOCALITIES								
	I. Straits of Johore				II. East Coast Road				
	Units			Locality Mean	Units			Locality Mean	Monthly Mean
	A	B	C		D	E	F		
1 ..	17.21	25.75	20.55	21.0	96.73	56.32	63.72	71.5	45.0
2 ..	19.04	17.84	12.13	16.4	93.74	52.50	58.33	67.1	40.9
3 ..	10.43	14.55	13.45	12.9	82.83	49.08	59.10	62.0	33.8
Unit Means ..	15.5	19.2	15.5	16.6	92.0	52.7	59.6	65.4	40.032

It will be seen that there is a considerable difference between the localities. This difference is so large that the further anályses was made by treating the two sets of data (locality) separately. The two analyses of variance are as follows:—

Table H

ANALYSIS OF VARIANCE OF THE DATA SUMMARIZED IN TABLE G

	df	*M.S.*	
Locality I.			
Units	2	404	
Months	2	1,359	
Days	29	17	
U X M	4	258	AM = 16.6 katties per day.
U X D	58	34	
M X D	58	31	
Remainder	82	31	
Total ..	235	48.383	

$\sigma = 6.955, \quad \frac{\sigma}{\sqrt{n}} = 0.454,$ C.V. = 2.72 per cent.

	df	*M.S.*	
Locality II.			
Units	2	28,998	
Months	2	1,386	
Days	29	3,681	AM = 65.4 katties per day.
U X D	58	978	
M X D	58	1,227	
Remainder	54	593	
Total ..	203	1,612	

$\sigma = 40.15, \quad \frac{\sigma}{\sqrt{n}} = 2.812,$ C.V. = 4.3 per cent.

The 'units' differences are significant in both cases; in the units from the Straits locality, the 'days' differences are significant, whilst the 'months' are not, whereas for the East Coast Road units the reverse is the case. It should be noted that the possible N for these sets was 270 in both cases; for the Straits set the number is only 203 and as a result the analysis is incomplete.

Interactions have been calculated for units against days, and days against months, and both are shown significant, the latter more than the former. In the case of the East Coast Road series the number is 235 and all three first order interactions have been estimated, and only units against days appears significant. The above table shows that the series have a coefficient of variation of 8.38 per cent for the Straits, and of 5.47 per cent for the East Coast Road. With reservations we may say that the mean for the former lies between 15.7 and 17.5 katties per day. Using the same formula for estimating the required sample size, as was used above for the *kelong*, we get results which indicate that 1 unit at Locality I and 3 units at Locality II, would give reliable estimates of the true catching level. We are reluctant to accept this result at this stage and propose not only to continue with three units at each locality but also to make further tests of variance in the operations of additional units as soon as that may be possible. However, the above results do indicate a surprising measure of uniformity of catches within each locality, month and unit, but not between locality.

3. *JARING HANYUT*

Records were taken from fifteen units over four months. The data contained so many days of no record that for the purposes of this analysis we have calculated the mean catch of the days of operation in each month for each unit and have made our analysis on these means; this procedure differs from the procedure followed in the case of the first analysis for the above two types of gear where the days variance was estimated. The result of this analysis is presented in Table I. It will be seen that the means have a sample size of about three units. For reasons similar to those given above we propose to continue this work on a larger sample than is indicated by this result and have arbitrarily set the figure at 10.

Table I

ANALYSIS OF VARIANCE OF MONTHLY MEAN DAILY CATCH OF FIFTEEN *JARING HANYUT* UNITS FOR PERIOD OF FOUR MONTHS

		df	*M.S.*	
Months	.. ..	3	39.17	
Units	.. ..	14	23.38	AM = 11.17 katties per day.
Remainder	.. ..	40	11.47	
	Total ..	57	15.80	

$\sigma = 3.975$, $\frac{\sigma}{\sqrt{n}} = 0.526$, C.V. = 4.7 per cent.

DISCUSSION

It will be noted that the foregoing is an analysis of the variability of certain records and that it contains no test of the reliability of the records themselves. The analysis assumes such reliability and proceeds to an estimate of the probable limits of variation of estimates of mean and total for the population of operations of which these records present a sample; and some suggestions are made for future sampling. The data relate to the catch actually landed or simply to the landings as distinct from the catch, and as the difference between these two are believed to be small and fairly constant it may be neglected. It is necessary, however, to investigate this discrepancy in some detail to ensure that the error that is introduced does not weaken the validity of the determination of total production.

A further discrepancy is undoubtedly introduced by the fact that the catch is measured by different means in respect of the returns obtained from the fishermen. In some cases the quantity is assessed by eye-estimate, but in most cases it is the weight which is recorded at the first wholesale sale, that is, the sale of fish by the fishermen to the wholesale agent or collector. This also requires further investigation and the amount of error which might arise must be estimated and a determination made as to whether it is significant or not. Again, in addition to the inevitable clerical errors, there may be a deliberate falsification of record arising from any of a number of motives; these range from the more or less innocuous rounding to a favoured figure such as 0 or 5, to over- or under-statement intended to mislead authority. This type of 'error' must also be assessed. When these several aspects have been considered and perhaps measured, a decision may be taken as to whether a system of 'control' of such error by a sampling programme specially designed to test the accuracy of the record, need be introduced.

Assuming that the present set of records are reasonably accurate, and that future records can be held at a similar level of accuracy (with or without a subsidiary testing programme) the present results suggest that the developed sampling programme will furnish useful estimates of production by the several methods to within most satisfactory fiducial limits.

Appendix III

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES

Series	Compiled and/or Published by	Publication	Remarks
MANPOWER			
1. Licensed fishermen	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore	
2. Estimates of fishermen operating fishing gear exempt from licensing (incomplete)	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore	To be replaced by census under implementation
3. Census Report	Crown Agent on behalf of the Governments of the Federation of Malaya and Colony of Singapore	Malaya comprising the Federation of Malaya and the Colony of Singapore 'A report on the Census of population, 1947.' *by* M. V. Del Tufo, M.A.	Published in 1949
EQUIPMENT			
1. Craft:— (*a*) Licensed fishing vessels by type and locality ..	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore	
(*b*) Catalogue of powered propelled vessels ..	Fisheries Department, Singapore	Issued quarterly. (Mimeoed)	Limited circulation only
2. Fishing Gear:— Licensed fishing gear by type and locality ..	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore	
3. Material used in the construction of:— (*a*) Fishing craft .. .. .. (*b*) Fishing gear	Nil Fisheries Department, Singapore	Nil (*a*) Malayan Statistics* (*b*) Annual Report, Fisheries Department, Singapore	Monthly

*Malayan Statistics:—

(1) General Section (with effect from January 1950. First published in April September 1950).
(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES—*continued*

Series	Compiled and/or Published by	Publication	Remarks
PRODUCTION			
1. Estimated local production	Fisheries Department, Singapore	Not published	Sample methods employed
2. Market handlings of local origin	Fisheries Department, Singapore from data supplied by the Municipal Council and own sources	(*a*) Malayan Statistics* (*b*) Annual Report, Fisheries Department, Singapore	
COST OF PRODUCTION			
1. Cost of fishing materials	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore Malayan Statistics*	
2. Cost of fishing gear	Fisheries Department, Singapore	Survey Report II†	
3. Cost of fishing craft	No data		Collection programme under implementation
4. Maintenance and repair of craft	No data		
5. Operating cost and depreciation of craft ..	Fisheries Department, Singapore		
VOLUME OF SUPPLY			
FRESH FISH			
1. Wholesale market handlings (in katties) (i) By markets (5)‡ comprising:— (2) since 1936 (incomplete) (2) since 1947 (1) since 1-7-50	Fisheries Department, and Municipal Council, Singapore	Annual Report, Fisheries Department, Singapore	
(ii) By types (56) From 2 municipal markets since 1-1-50 From 3 private markets since 1-7-50		Malayan Statistics*	
(iii) By localities (49) since 1947 to date			

*Malayan Statistics:—
(1) General Section (with effect from January 1950. First published in April September 1950).
(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).
†Fisheries Survey Report No. 2 'The Fishing Gear of the Colony of Singapore'. (In press).
‡Figures within brackets relate to the number of individual divisions within each series.

Appendix III—*continued*

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES—*continued*

Series	Compiled and/or Published by	Publication	Remarks
VOLUME OF SUPPLY—*continued*			
FRESH FISH—*continued*			
2. Imports and Exports of fresh fish:— (i) By localities (on occurrence) (ii) By tonnage and value and origin/destination	Department of Malayan Statistics, Singapore	Malayan Statistics* (Monthly with cumulative totals from 1st January)	Pan-Malayan, does not include internal trade or production in local waters
3. Federation of Malaya Imports and Exports of fresh fish:— (i) By localities (ii) By tonnage and value and origin/destination	Central Trade Registry, Kuala Lumpur	Not published	Including internal trade between Federation of Malaya and Colony of Singapore
4. Direct supply from importers to institutes, the armed forces, and hospitals— By types (as given) daily	Fisheries Department, Singapore	Not published	
5. Imports of fish by rail from the Federation of Malaya†	Fisheries Department, Singapore	Not published	Information supplied by Goods Agent, Malayan Railways, Singapore
6. Imports of fish by air from the Federation of Malaya	Fisheries Department, Singapore	Not published	Information supplied by the Department of Civil Aviation, Singapore
7. Total imports of fish from all areas by vessels— By types (56) By localities (10)	Fisheries Department, Singapore	Not published	From Riouw Residency—June 1950 From all areas—May 1950
8. Auction records for markets (2)— By types (as given) daily For Agents (as licensed)	Market section, Municipality, Singapore	Not published	Series incomplete

*Malayan Statistics. (External Trade)—Monthly with cumulative total from 1st January.
†Including other marine products.

Series	Compiled and/or Published by	Publication	Remarks
PRICE DATA (FRESH FISH) (Cents per katty)			
1. 1941 Controlled Retail Prices	Food Controller, Singapore	*Gazette* Extraordinary No. 127 of 1st December, 1941	
2. Comparative monthly average Retail Price for Municipal Markets of Singapore, Penang, Kuala Lumpur, etc.	Department of Malayan Statistics, Singapore	Malayan Statistics*	13 types
3. Monthly average retail price in Municipal Markets, Singapore	Fisheries Department, Singapore	Malayan Statistics† Singapore Government *Gazette*	13 types. Information supplied by Municipal Health Office
4. Daily retail price in Ellenborough and Clyde Terrace Markets	Municipal Health Office, Singapore	Not published	
5. Daily retail price observed by Food Control Department, Singapore	Food Control Department, Singapore	Not published	
6. First wholesale price— By fishing villages (15) By types (as given)	Fisheries Department, Singapore	Annual Report, Fisheries Department, Singapore	Reported by fishermen as to actual receipt or by headman as observed price, daily. (Prices reported by the fishermen relate morning transactions)
7. Last wholesale price— By areas (9) By types (as given)	Fisheries Department, Singapore	Not published	Reported by collectors as to actual price received. (This price is equivalent to the auction price less the market levy the auction agent's commission)

*Malayan Statistics. (External Trade)—Monthly with cumulative total from 1st January.

†Malayan Statistics:—

(1) General Section (with effect from January 1950. First published in April/September 1950).

(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).

Appendix III—*continued*

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES—*continued*

Series	Compiled and/or Published by	Publication	Remarks
PRICE DATA (FRESH FISH)—*continued* (Cents per katty)			
8. Auction Price— By types (20) By markets (5) A. 2 Municipal Markets 3 Private Markets	Fisheries Department, Singapore	Not published	Reported by agents market owners (10) Municipal staff (2 markets only)—1949 and 1950 (monthly). Daily, November, December 1950
B. By types (as given) By Markets (2) from actual auction records	Fisheries Department, Singapore	Not published	
9. Retail Price (Cents per unit katty) A. By types (9) graded into 3 classes	Fisheries Department, Singapore	Not published	Impression of Food Control Inspectors in two of four markets, from direct observation of actual transaction
B. By types (20) from major markets (2)	Fisheries Department, Singapore	Malayan Statistics* Annual Report Fisheries Department, Singapore	Price reported by retailers to Municipal staff daily
C. By types (20) from markets (30)	Fisheries Department, Singapore	Discontinued	Observed by Fisheries Department Staff and/or reported by retailers daily
D. By types (as given) from consumer (1) from locality (1)	Fisheries Department, Singapore	Not published	Price at which offered by or purchased from an itinerant hawker

*Malayan Statistics:—
(1) General Section (with effect from January 1950. First published in April/September 1950).
(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).

Appendix III—*continued*

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES—*continued*

Series	Compiled and/or Published by	Publication	Remarks
DRIED AND SALTED FISH			
1. Singapore Imports and Exports of Fish, dried and salted (Monthly by tonnage and value by origin/destination)	Department of Statistics, Singapore	Annual Report, Fisheries Department, Singapore	Trade with:— (1) Other Countries (2) Federation of Malaya (3) Total Trade
2. Federation Imports and Exports of Fish, dried and salted (Monthly as above)	Central Trade Registry, Kuala Lumpur	Not published	Includes statement of trade with Singapore (Incorporated in 1)
3. Local Production	Fisheries Department, Singapore	Monthly Diary	Estimation
4. Comparative monthly average retail price for Municipal markets of Singapore, Penang, Kuala Lumpur, etc.	Department of Statistics, Singapore	Malayan Statistics*	10 types
5. Import and Export prices of Fish, dried and salted (Quarterly for 1947, 1948 and 1949 only)	Department of Statistics, Singapore	Malayan Statistics General section (1950 editions only)	Value in Malayan $ per unit of quantity

*Malayan Statistics:—
(1) General Section (with effect from January 1950. First published in April-September 1950).
(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).

Appendix III—*continued*

SOURCE REFERENCES FOR RECENT STATISTICAL SERIES—*continued*

Series	Compiled and/or Published by	Publication	Remarks
MARINE PRODUCE			
(Includes Belachan, Beche-de-Mer, Seaweed, Fish Maws, Green Snails and Trocus Shells, Canned Fish, Shark's Fin and Fish for manure)			
1. Singapore Imports and Exports of Marine Produce (Monthly by tonnage and value)	Department of Statistics, Singapore	Malayan Statistics*	Also published in Annual Report includes:— (1) Foreign Trade (2) Trade with Federation of Malaya
2. Federation Imports and Exports of Marine Produce (Monthly by tonnage and value)	Central Trade Registry, Kuala Lumpur	Not published	Includes statement of trade with Singapore
3. Monthly average wholesale prices Fish Maws, Unselected Green Snails and Trocus Shells	Department of Statistics, Singapore	Malayan Statistics*	

*Malayan Statistics:—

(1) General Section (with effect from January 1950. First published in April/September 1950).

(2) Monthly Digest (with effect from January 1951. First published in May 1951 to date).

9. STATISTICAL BIBLIOGRAPHY

Croxton, F. E. and D. J. Cowden (1939) Applied General Statistics. (Prentice-Hall, New York.)

Demming, W. E. (1950) .. .. Some Theory of Sampling. (Wiley, New York.)

Fisher, R. A. (1946) .. .. Statistical Methods for Research Workers. (Oliver and Boyd, Edinburgh.)

Mather, K. (1949) .. .. Statistical Analysis in Biology. (Metheun, London.)

Snedecor, G. W. (1946) .. .. Statistical Method. (Iowa, U.S.A.)

Yates, F. (1949) .. .. Sampling Methods for Censuses and Surveys (Griffin, London.)